(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 242 140 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication of patent specification: **11.09.91** (51) Int. Cl.5: **A47C 1/032**, A47C 3/026

(21) Application number: **87303153.8**

(22) Date of filing: **10.04.87**

# (54) Integrated chair and control.

(30) Priority: **10.04.86 US 850268**

(43) Date of publication of application:
**21.10.87 Bulletin 87/43**

(45) Publication of the grant of the patent:
**11.09.91 Bulletin 91/37**

(84) Designated Contracting States:
**DE FR GB**

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**EP 0 242 140 B1**

## Description

The present invention relates to seating, and in particular to an integrated chair and control arrangement therefor.

Articulated seating, such as tilt back chairs, and other furniture articles of the type having at least two mutually adjustable portions, are used extensively in office environments. The mutually adjustable portions of the seating are normally interconnected by a controller or control, which mechanically adjusts the mutual orientation of the various adjustable seating portions. Seating controls normally include springs which bias the seating into a normal or upright position. The controls also typically include some type of adjustment device to vary the biasing force which resists movement of the adjustable portions of the seating from their normal position.

Synchrotilt chair controls, such as the device described in US-A-4 390 206, provide a mechanism which causes the chair back to rotate at a rate different from that of the chair bottom or seat. Such mechanisms are generally referred to as "synchrotilt" controls, since the chair back and chair bottom move in a synchronous fashion. Normally, synchrotilt controls cause the chair back to tilt at a faster rate than the chair bottom, so that as the user tilts the chair back rearwardly, the user's feet are less likely to be lifted off of the floor by the rising front edge of the chair bottom.

Chair controls are normally mounted below the chair bottom, so that they do not interfere with the use of the chair, and so that they do not detract from the aesthetics of the chair design.

Prior synchrotilt chair controls, such as that described in US-A-4 390 206 referred to above, have a rather complicated construction, and are rather large and bulky. Such devices have a two-part articulated iron construction, with a fixed axle about which back and seat support portions of the iron rotate. The control is completely separate or independent from the chair or shell, and mutually rotates the chair back and chair bottom about the fixed axle, which is located below the chair bottom.

It has been found with such synchrotilt chairs that they do not flex or articulate in a comfortable, natural fashion in tune with the user's body. The chair back tends to pull away from the lumbar area of the user as the chair back tilts rearwardly. As a result, the user's lumbar area does not receive full support throughout all chair positions, and some degree of muscle fatigue can possibly result.

Also, as the chair back tilts rearwardly, the chair back moves longitudinally along the user's back, and rubs or abrades on the same. This motion can be somewhat uncomfortable, but more importantly, typically dishevels or otherwise pulls the user's clothing from its proper position. For example, if the user is wearing separate top and bottom clothes, such as a shirt and trousers, rearward tilting of the chair back will pull the user's shirt from its proper position in the user's trousers.

EP-A-0049310 describes a synchrotilt chair with a chair bottom pivotally connected at one end to a base and flexibly at the other end to a chair back. The chair back is also connected by a link to the base. When the chair is reclined, the chair back rotates about the rear end of the chair bottom relative to the chair bottom, and this results in shirt pull.

It is an object of the present invention to overcome these problems which are encountered in known synchrotilt chairs according to the preamble of claim 1.

The problems are solved by the invention, according to the characterizing part of claim 1.

It has been realised that the problems of the previous synchrotilt chairs arise from the fact that the synchrotilt axis, being located below the seat, is spaced a significant distance, typically l25 to 305 mm (5 to 8 inches), from the hip joints of the seated user, which is where the user's upper body or torso pivots naturally and comfortably with respect to the user's legs. The hip joints of an average user, seated upright with good posture in the chair, normally lie along an imaginary, generally horizontally oriented axis above the seating surface of the chair bottom, approximately 76 to 102 mm (3 to 4 inches), and forwardly of the plane of the seating surface on the chair back, approximately 76 to 127 mm (3 to 5 inches). The position of this "hip joint axis" in side elevational view with respect to a chair is generally referred as the "H" point. Although the "H" point varies from one individual to another, depending upon the particular size, shape and other physical characteristics of the user, a model or preferred "H" point can be derived empirically, based upon studies of a wide range of different types of uses.

FR-A-2451472 discloses various chairs which consist of chair bottoms connected to chair backs by mechanisms consisting of a series of pivoted links and springs. This document discloses those features set out in the precharacterising portion of claim 1. The mechanisms result in synchrotilt axes which move relative to the "H" point during operation. It is clear from above that it is desirable to maintain the "H" point at all times adjacent to the common axis about which the chair back and bottom rotate with respect to one another.

According to the present invention there is provided a chair with those features of the characterising portion of claim 1.

The present invention provides an integrated chair and control arrangement which locates the

common axis about which the chair back and chair bottom rotate with respect to each other at a location adjacent to the "H" point, or hip joints of a seated user. A control supports the chair back and the chair bottom in a manner such that rearward tilting of the chair back simultaneously shifts the chair back, the chair bottom, and the location of the common axis in a manner which maintains the adjacent spatial relationship between the common axis and the hip joints of the seated user to provide improved comfort and support.

Preferably, the front portion of the chair bottom moves upward and downward independently of the control to alleviate undesirable pressure, and/or disruption of blood circulation in the user's legs, particularly when the chair back is tilted rearwardly, or when the chair is raised quite high to work at an elevated work surface. Also, the upper portion of the chair back, as well as the forward portion of the chair bottom, preferably flexes independently of the chair, to provide increased freedom of movement for both the upper and lower portions of the user's body.

It is possible, by utilising the present invention, to provide a chair whose appearance and performance are attuned to the shape and movement of the user's body, even while the user is performing a variety of tasks. The chair may have a one-piece, sculptured design that mirrors the human form, and will flex or articulate in a very natural fashion in response to the user's body shape and body movement to optimize both comfort and support in every chair position.

It is possible to construct a chair which has a dynamic or living feeling, the chair sensing the body movements of the user, and deforming and/or moving in reaction thereto to follow the natural movement of the user's body as various tasks and activities are performed, while at the same time, providing improved, highly controlled, postural support. The control arrangement causes the chair to articulate and flex in a predetermined, controlled pattern, and provides a very safe and secure feeling, as opposed to the type of free, uncontrolled flexing that is experienced in conventional moulded seating that does not have a mechanically controlled chair back. The chair may be constructed to provide good, uniform back support all along the user's spine, and this support is maintained throughout the various tilt positions. The control may be located wholly below the chair bottom to avoid interfering with the use of the chair, and to improve the aesthetics of the overall chair design.

The chair back and chair bottom are interconnected to rotate about a common axis located above the chair bottom, and forward of the chair back, and generally adjacent to the "H" point or hip joint axis of a seated user. In a preferred construction of chair, when the chair back is tilted rearwardly, the chair back, along with at least a portion of the chair bottom, shifts in a manner which simulaneously shifts the location of the common axis along a path which maintains the adjacent spatial relationship between the common axis and the "H" point to provide improved comfort and support. The chair may have a sleek, single shell type of construction, with integral back and bottom portions that rotate in a synchrotilt pattern. The synchrotilt articulation may have a relatively uncomplicated construction, and improved range. In the preferred construction, the seating portions of the chair are integral parts of the control, thereby providing a lean, low profile appearance, as well as a very natural, comfortable tilting action, that results in improved lumbar support in all chair positions, and alleviates shirt pull.

The invention may be carried into practice in various ways but one tilt back chair embodying the invention will now be described by way of example with reference to the accompanying drawings in which:

Fig. 1 is a perspective view of the chair, with portions thereof broken away to reveal the integrated chair and control arrangement;

Fig. 2 is a perspective view of the chair, wherein the upholstery has been removed to reveal the shell of the chair;

Fig. 3 is a perspective view of the chair, wherein the upholstery and shell have been removed to reveal a control portion of the chair;

Fig. 4 is an exploded, perspective view of the chair;

Fig. 5 is an exploded, perspective view of the control;

Fig. 6 is a side elevational view of the chair in a partially disassembled condition and partly in section, shown in a normally upright position;

Fig. 7 is a side elevational view of the chair illustrated in Fig. 6, shown in a rearwardly tilted position;

Fig. 8 is a top plan view of a back portion of the shell, shown in the upright position;

Fig. 9 is a top plan view of the shell, shown in the upright position, with one side flexed rearwardly;

Fig. 10 is a vertical cross-sectional view of the chair;

Fig. 11 is a perspective view of the chair, shown in the upright position;

Fig. 12 is a perspective view of the chair, shown in the rearwardly tilted position;

Fig. 13 is a bottom plan view of the shell;

Fig. 14 is a rear elevational view of the shell;

Fig. 15 is a horizontal cross-sectional view of the shell, taken along the line XV-XV of Fig. 14;

Fig. 16 is a top plan view of the control, wherein

portions thereof have been removed and exploded away to reveal internal construction;

Fig. 17 is a bottom plan view of a bearing pad portion of the control;

Fig. 18 is a side elevational view of the bearing pad;

Fig. 19 is a vertical cross-sectional view of the bearing pad, shown mounted in the control;

Fig. 20 is a bottom plan view of a rear arm strap portion of the control;

Fig. 21 is bottom plan view of a front arm strap portion of the control;

Fig. 22 is a fragmentary, top plan view of the chair, wherein portions thereof have been broken away to reveal internal construction;

Fig. 23 is an enlarged, fragmentary vertical cross-sectional view of the chair, taken along the line XXIII-XXIII of Fig. 22;

Fig. 24 is an enlarged, rear elevational view of a guide portion of the control;

Fig. 25 is a top plan view of the guide;

Fig. 26 is an enlarged, perspective view of a pair of the guides;

Fig. 27 is an enlarged, front elevational view of the guide;

Fig. 28 is an enlarged, side elevational view of the guide;

Fig. 29 is a vertical cross-sectional view of the chair, taken along the line XXIX-XXIX of Fig. 22;

Fig. 30 is a vertical cross-sectional view of the chair, similar to Fig. 29, wherein the right-hand side of the chair bottom (as viewed by a seated user) has been flexed downwardly;

Fig. 31 is a diagrammatic illustration of a kinematic model of the integrated chair and control, with the chair shown in the upright position;

Fig. 32 is a diagrammatic illustration of the kinematic model of the integrated chair and conrol, with the chair back shown in the rearwardly tilted position;

Fig. 33 is a fragmentary, vertical cross-sectional view of the chair, shown in the upright position, and unoccupied;

Fig. 34 is a fragmentary, vertical cross-sectional view of the chair, shown in the upright position, and occupied, with a forward portion of the chair bottom moved slightly downwardly;

Fig. 35 is a fragmentary, vertical cross-sectional view of the chair, shown in the upright position, and occupied, with the front portion of the chair bottom positioned fully downwardly;

Fig. 36 is a fragmentary, vertical cross-sectional view of the chair, shown in the rearwardly tilted position, and occupied, with the front portion of the chair bottom positioned fully upwardly, and wherein broken lines illustrate the position of the chair in the upright position;

Fig. 37 is a fragmentary, vertical cross-sectional view of the chair, shown in the rearwardly tilted position, and occupied, with the forward portion of the chair bottom located fully upwardly, and wherein broken lines illustrate the position of the chair bottom in three different positions;

Fig. 38 is a fragmentary, vertical cross-sectional view of the chair, shown in the rearwardly tlited position, and occupied, with the forward portion of the chair bottom positioned fully downwardly; and

Fig. 39 is a fragmentary, enlarged vertical cross-sectional view of the chair bottom, taken along the line XXXIX-XXXIX of Fig. 3.

The reference numeral 1 (Figs. 1-3) generally designates an integrated chair and control arrangement embodying the present invention, comprising a chair 2, and a control 3 therefor. Integrated chair and control arrangement 1 is shown herein as incorporated in a tilt back type of chair 2. Chair 2 includes a base 4, a backrest or chair back 5, and a seat or chair bottom 6, which are interconnected for mutual rotation about a common or synchrotilt axis 7. Control 3 includes a normally stationary support or housing 8, and a back support 9 rotatably connecting chair back 5 with housing 8 to permit rotation therebetween about a back pivot axis 10 (Fig. 6 and 7). Control 3 (Fig. 3) also includes a bottom support 11 rotatably connecting chair bottom 6 with housing 8 to permit rotation therebetween about a bottom pivot axis 12 (Fig. 31 and 32). As best illustrated in Fig. 34, the common or synchrotilt axis 7 is located above chair bottom 6, forward of chair back 5, and generally adjacent to the hip joint axis, or "H" point 13 of a seated user. Rearward tilting of chair back 5 simultaneously shifts chair back 5, chair bottom 6, and the location of common axis 7 in a manner which maintains the adjacent spatial relationship between the common axis 7 and the "H" point 13 to provide improved user comfort and support.

With reference to Fig. 4, chair 2 has a sleek, one-piece design. Chair 2 is supported on base 4, which includes casters 14 and a moulded cap 15 that fits over the legs of base 4. Control 3 is mounted on base 4, and includes a lower cover assembly 16. Chair 2, along with left-hand and right-hand arm assemblies 17, are supported on control 3. A moulded cushion assembly 18 is attached to the front surface of chair 2 through fastener apertures 23, and provides a continuous, one-piece comfort surface on which the user sits. A rear, cover shell assembly 19 is attached to the rear surface of chair 2, through fastener apertures 24, and a bottom shell assembly 20 is attached to the bottom of chair 2 by conventional fasteners (not shown).

With reference to Fig. 5, chair 2 also includes a weight actuated, height adjuster assembly 21. A

variable back stop assembly 22 is also provided on control 3 to adjustably limit the rearward tilting action of chair back 5.

In the illustrated chair 2 (Fig. 4), cushion assembly 18 is a moulded, one-piece unit that has three separate areas which are shaped and positioned to imitate or mirror the human body. Chair back 5 and chair bottom 6 are also moulded in a unitary or integral shell 2a, which serves to support cushion assembly 18 in a manner that allows the user to move naturally and freely in chair 2 during the performance of all types of tasks and other activities. Chair shell 2a is constructed of a resilient, semi-rigid, synthetic resin material, which normally retains its moulded shape, but permits some flexing, as described in greater detail below. Chair shell 2a includes the two sets of fastener apertures 23 and 24, as well as five sets of threaded fasteners 24-28 mounted therein to facilitate interconnecting the various parts of chair 2, as discussed hereinafter.

As best illustrated in Figs. 13-15, chair shell 2a comprises a relatively thin, formed sheet 12, with a plurality of integrally moulded, vertically extending ribs 30 on the back side thereof. Ribs 30 extend from a rearward portion 31 of chair bottom 6 around a curved centre or intermediate portion 32 of chair shell 2a, which is disposed between chair back 5 and chair bottom 6. Ribs 30 extend along a portion 33 of chair back 5. In the illustrated example, chair shell 2a has eight ribs 30, which are arranged in regularly spaced apart pairs, and are centred symmetrically along the vertical centreline of chair shell 2a. Ribs 30 protrude rearwardly from the back surface of chair back 5 a distance in the nature of 12.7 to 25.4 mm (1/2 to one inch). Ribs 30 define vertically extending slots 46 in which associated portions of control 3 are received, as described below. The sheet 29 of chair shell 2a is itself quite pliable, and will therefore bend and flex freely in either direction normal to the upper and lower surfaces of the sheet 29. Ribs 30 serve to selectively reinforce or stiffen sheet 29, so that it will assume a proper configuration to provide good body support along the central portions of chair shell 2a, yet permit flexure at the peripheral or marginal portions of chair shell 2a. Ribs 30, in conjunction with uprights 76 and 77 (to be described below), define a substantially rigid portion of the chair shell 2a, which does not readily bend or flex in a vertical plane, and generally corresponds to the spine area of a seated user.

The marginal portion of the chair back 5 (Fig. 14), which is disposed outwardly from ribs 30, is divided into an upper portion 34, a left-hand portion 35, and a right-hand portion 36. That portion of chair bottom 6 (Fig. 13) which is located outwardly from ribs 30, includes a forward portion 37, a right-hand portion 38, and a left-hand portion 39.

A second set of ribs 45 (Fig. 14) are integrally formed on the back surface of chair shell 2a, and are arranged in an "X" shaped configuration thereon. Ribs 45 extend from the upper portion 34 of chair back 5, at the upper ends of vertical ribs 30, downwardly across the surface of chair back 5, and terminate at points located adjacent to the inwardmost pair of vertical ribs 30. Ribs 45, along with ribs 30, selectively rigidify the upper portion of chair back 5 to prevent the same from buckling when rearward force or pressure is applied thereto. However, ribs 30 and 45 permit limited lateral flexing about a generally vertical axis, and in a generally horizontal plane, as illustrated in Figs. 8 and 9, to create additional freedom of movement for the upper portion of the user's body, as described in greater detail hereinafter.

Chair shell 2a (Fig. 13) includes a generally arcuately shaped flex area 50 located immediately between the rearward and forward portions 31 and 37 respectively of chair bottom 6. As best shown in Figs. 11 and 12, since chair shell 2a is a moulded, one-piece unit, flex area 50 is required to permit chair back 5 to pivot with respect to chair bottom 6 along synchrotilt axis 7. In the illustrated example, flex area 50 comprises a plurality of elongated slots 51 that extend through chair shell 2a in a predetermined pattern. Slots 51 selectively relieve chair shell 2a at the flex area 50, and permit it to flex, simulating pure rotation about synchrotilt axis 7.

A pair of hinges 52 (Figs. 11 and 12) rotatably interconnect chair back 5 and chair bottom 6, and serve to locate and define synchrotilt axis 7. In the illustrated example, hinges 52 comprise two, generally rectangularly shaped, strap-like living hinges, positioned at the outermost periphery of shell 2a. The opposite ends of living hinges 52 are moulded with chair back 5 and chair bottom 6, and integrally interconnect the same. Living hinges 52 bend or flex along their length, to permit mutual rotation of chair back 5 and chair bottom 6 about synchrotilt axis 7, which is located near the centre of living hinges 52. Living hinges 52 are located at the rearward, concave portion of chair bottom 6, thereby positioning synchrotilt axis 7 adjacent to the hip joints of a seated user, above the central area of chair bottom 6, and forward of chair back 5. In this example, synchrotilt axis 7 is located at a level approximately halfway between the upper and lower surfaces of living hinges 52.

When viewing chair 2 from the front, as shown in Fig. 4, chair shell 2a has a somewhat hourglass shape, wherein the lower portion 33 of chair back 5 is narrower than both the upper portion 34 of chair back 5, and the chair bottom 6. Furthermore, the rearward portion 31 of chair bottom 6 is bucket-shaped or concave, thereby locating living hinges

52 substantially coplanar with the synchrotilt axis 7, as best shown in Fig. 38. The forward portion 37 of chair bottom 6 is relatively flat, and blends gently into the concave, rearward portion 3l of chair bottom 6. Three pairs of mounting pads 53-55 (Fig. l3) are moulded in the lower surface of chair bottom 6 to facilitate connecting the same with control 3, as discussed below.

Castered base 4 (Fig. 5) includes two vertically telescoping column members 56 and 57. The upper end of upper column member 57 is closely received in a mating socket 58 in control housing 8 to support control housing 8 on base l4 in a normally, generally stationary fashion.

Control housing 8 (Fig. 5 and l0) comprises a rigid, cup-shaped, formed metal structure having an integrally formed base 60, front wall 6l, rear wall 62, and opposite sidewalls 63. A laterally oriented bracket 59 is rigidly attached to housing base 60 and sidewalls 63 to reinforce control housing 8, and to form column socket 58. Control housing 8 includes a pair of laterally aligned bearing apertures 64 through housing sidewalls 63, in which a pair of antifriction sleeves or bearings 65 are mounted. A pair of strap-like, arcuately shaped rails 66 are formed integrally along the upper edges of housing sidewalls 63, at the forward portions thereof. Rails 66 extend or protrude slightly forwardly from the front edge of control housing 8. In the illustrated example, rails 66 have a generally rectangular, vertical cross-sectional shape, and are formed or bent along a downwardly facing arc, having a radius of approximately ll4 to l40 mm (4-l/2 to 5-l/2 inches), with the centre of the arc aligned generally vertically with the forward ends 67 of rails 66, as shown in Figs. 6 and 34. The upper and lower surfaces of rails 66 are relatively smooth, and are adapted for slidingly supporting chair bottom 6 theron.

Control 3 also includes an upright weldment assembly 75 (Fig. 5) for supporting chair back 5. Upright weldment assembly 75 includes the pair of rigid, S-shaped uprights 76 and 77, which are spaced laterally apart a distance substantially equal to the width of rib slots 46, and are rigidly interconnected by a pair of transverse straps 78 and 79. A pair of rear stretchers 80 and 8l are fixedly attached to the lower ends of upright 76 and 77, and include clevis type brackets 82 at their forward ends in which the opposing sidewalls 63 of control housing 8 are received. Clevis brackets 82 include aligned, lateral apertures 83 therethrough in which axle pins 84 with flareable ends are received, through bearings 65 to pivotally attach weldment assembly 75 to control housing 8. Bearings 65 are positioned such that the back pivot axis l0 is located between the forward portion 37 and the rearward portion 3l of chair bottom 6. As a result, when chair back 5 tilts rearwardly, the rearward portion 3l of chair bottom 6, along with synchrotilt axis 7, drops downwardly with chair back 5. In the illustrated structure, back pivot axis l0 is located approximately 63 to 89 mm (2-l/2 to 3-l/2 inches) forward of synchrotilt axis 7, and around 76 to l02 mm (3 to 4 inches) below synchrotilt axis 7, such that chair back 5 and the rearward portion 3l of chair bottom 6 drop around 50 to l02 mm (2 to 4 inches) when chair back 5 is tilted from the fully upright position to the fully rearward position.

As best illustrated in Figs. 5 and l0, control 3 includes a pair of torsional springs 70, and a tension adjuster assembly 7l to bias chair 2 into a normally, fully upright position. In the illustrated structure, tension adjuster assembly 7l comprises an adjuster bracket 72 having its forward end pivotally mounted in the front wall 6l of control housing 8. The rearward end of adjuster bracket 72 is fork-shaped to rotatably retain a pin 73 therein. A threaded adjustment screw 74 extends through a mating aperture in housing base 60, and has a knob mounted on its lower end, and its upper end is threadedly mounted in pin 73. A stop screw 86 is attached to the upper end of adjuster screw 74, and prevents the same from inadvertently disengaging. Torsional springs 70 are received in control housing 8, and are mounted in a semi-cylindrically shaped, ribbed spring 87. Torsional springs 70 are positioned so that their central axes are oriented transversely in control housing 8, and are mutually aligned. The rearward legs of torsional springs 70 (Fig. l0) abut the forward ends of clevis brackets 82, and the forward legs of torsional springs 70 are positioned beneath, and abut adjuster bracket 72. Rearward tilting of chair back 5 pushes the rear legs of torsional springs 70 downwardly, thereby further coiling or tensing the same, and providing resilient resistance to the back tilting of chair back 5. Torsional springs 70 are pretensed, so as to retain chair 2 in its normally, fully upright position, wherein chair back 5 is angled slightly rearwardly from the vertical, and chair bottom 6 is angled slightly downwardly from front to rear from the horizontal, as shown in Figs. 6, l0, ll, 33 and 34. Rotational adjustment of adjuster screw 74 varies the tension in torsional springs 70 to vary both the tilt rate of chair back 5 and the pretension in springs 70.

Rear stretchers 80 and 8l (Fig. 5) include upwardly opening, arcuately shaped support areas 90. A rigid, elongate, arcuately shaped cross stretcher 9l is received on the support areas 90 of rear stretchers 80 and 8l, and is fixedly attached thereto by suitably means such as welding or the like. Cross stretcher 9l is centred on rear stretchers 80 and 8l, and the outward ends of cross stretcher 9l protrude laterally outwardly from rear stretchers

80 and 81. In the illustrated example, stretcher 91 comprises a rigid strap, constructed from formed sheet metal. The upper bearing surface 92 of cross stretcher 91 is in the shape of an arc, which has a radius of approximately 38 to 64 mm (1-1/2 to 2-1/2 inches). The arc formed by bearing surface 92 is substantially concentric with the common or synchrotilt axis 7, and in fact defines the synchrotilt axis about which chair back 5 rotates with respect to chair bottom 6. Cross stretcher 91 is located on rear stretchers 80 and 81 in a manner such that the longitudinal centreline of upper bearing surface 92 is disposed generally vertically below or aligned with synchrotilt axis 7 when chair 4 is in the fully upright position.

Control 3 further comprises a rigid, rear arm strap 100, which as best illustrated in Fig. 20, has a somewhat trapezoidal plan configuration, with forward and rearward edges 101 and 102, and opposite end edges 103 and 104. Rear arm strap 100 includes a central base area 105, with upwardly bent wings 106 and 107 at opposite ends thereof. Arm strap base 105 includes two longitudinally extending ribs 108 and 109 which protrude downwardly from the lower surface of arm strap base 105, and serve to strengthen or rigidify rear arm strap 100. Rib 108 is located adjacent to the longitudinal centreline of arm strap 100, and rib 109 is located adjacent to the rearward edge 102 of arm strap 100. Both ribs 108 and 109 have a substantially semicircular vertical cross-sectional shape, and the opposite ends of rib 108 open into associated depressions or cups 110 with threaded apertures 111 therethrough. The wings 106 and 107 of rear arm strap 100 each include two fastener apertures 112 and 113.

As shown in Fig. 5 and best illustrated in Figs. 16-19, bearing pads 95 and 96 are substantially identical in shape, and each has an arcuately shaped lower surface 119 which mates with the upper bearing surface 92 of cross stretcher 91. Bearing pads 95 and 96 also have arcuate grooves or channels 120 in their upper surfaces, which provide clearance for the centre rib 108 of rear arm strap 100. Each bearing pad 95 and 96 includes an outwardly extending ear portion 121, with an elongate slot 122 therethrough oriented in the fore-to-aft direction. Integrally formed guide portions 123 of bearing pads 95 and 96 project downwardly from the lower surface 119 of pad ears 122, and form inwardly facing slots or grooves 124 in which the end edges of cross stretcher 91 are captured, as best illustrated in Fig. 19. The guide portions 123 of bearing pads 95 and 96 include shoulder portions 125, which are located adjacent to the outer sidewalls of rear stretchers 80 and 81. Shouldered screws 126, with enlarged heads or washers extend through bearing pad apertures 122, and have threaded ends received in mating threaded apertures 111 in rear arm bracket 100 to mount bearing pads 95 and 96 to the lower surface of rear arm bracket 100.

During assembly, bearing pads 95 and 96 are positioned on the upper bearing surface 92 of cross stretcher 91, at the opposite ends thereof, with the ends of cross stretcher 91 received in the grooves 124 of bearing pads 95 and 96. Rear arm strap 100 is positioned on top of bearing pads 95 and 96, with rib 108 received in the arcuate grooves 120 in the upper surfaces of pads 95 and 96. Shouldered fasteners 126 are then inserted through pad apertures 112, and screwed into threaded apertures 111 in rear arm strap 100, so as to assume the configuration illustrated in Fig. 3. As a result of the acruate configuration of both bearing surface 93 and the mating lower surfaces 119 of bearing pads 95 and 96, fore-to-aft movement of rear arm strap 100 causes both rear arm strap 100, and the attached chair bottom 6, to rotate about a generally horizontally oriented axis, which is concentric or coincident with the common or synchrotilt axis 7.

A slide assembly 129 (Fig. 5) connects the forward portion 37 of chair bottom 6 with control 3 in a manner which permits fore-to-aft, sliding movement therebetween. In the illustrated example, slide assembly 129 includes a front arm strap assembly 130, with a substantially rigid, formed metal bracket 131 having a generally planar base area 132 (Fig. 21), and offset wings 133 and 134 projecting outwardly from opposite sides thereof. Two integrally formed ribs 135 and 136 extend longitudinally along the base portion 132 of front bracket 131 adjacent the forward and rearward edges thereof to strengthen or rigidify front bracket 131. Ribs 135 and 136 project downwardly from the lower surface of front bracket 131, and have a substantially semicircular vertical cross-sectional shape. A pair of Z-shaped brackets 137 and 138 are mounted on the lower surface of front bracket 131, and each includes a vertical leg 139, and a horizontal leg 140 (Figs. 29 and 30).

With reference to Figs. 22-30, front arm strap assembly 130 also includes a spring 145, which is connected with front bracket 131. Spring 145 permits the forward portion 37 of chair bottom 6 to move in a vertical direction, both upwardly and downwardly, independently of control 3, so as to alleviate undesirabe pressure and/or the restricting of blood circulation in the forward portion of the user's legs and thighs. In the illustrated example, spring 145 comprises a laterally oriented leaf spring that is arcuately shaped in the assembled, unloaded condition illustrated in Fig. 29. The opposite ends of leaf spring 145 are captured in a pair of guides 147. Guides 147 each have an upper, rectangular pocket 148 in which the associated leaf spring end is received, and a horizontally oriented slot 149 disposed below pocket 146, and extending through

guide 147 in a fore-to-aft direction. When assembled, the centre of leaf spring 145 is positioned between bracket ribs 135 and 136, and guides 147 are supported in brackets 137 and 138. The vertical legs 139 of brackets 137 and 139 have inwardly turned ends that form stops 150 (Fig. 23) which prevent spring 145 and guides 147 from moving forwardly out of brackets 137 and 138. The base portion 132 of front bracket 131 includes a downwardly protruding stop 151 formed integrally with rib 136, and is located directly behind the central portion of spring 145 to prevent spring 145 and guides 147 from moving rearwardly out of brackets 137 and 138. Hence, stops 150 and 151 provide a three point retainer arrangement that captures spring 145 and guides 147, and holds the same in their proper position on front bracket 131.

The height of guides 147 is substantially less than the height of mating brackets 137 and 138, so as to permit front bracket 131 to translate downwardly with respect to control housing 8 in the manner illustratd in Fig. 30. The upwardly bowed, centre portion of spring 145 engages the centre area of bracket base 132, and exerts a force on the guides 147. The horizontal legs 140 of brackets 137 and 138 resist the force exerted by spring 145, and retain spring 145 in place. The vertical deflection or motion of the chair bottom 6 is limited by abutting contact between guides 147 and mating brackets 137 and 138. When one, or both ends of spring 145 are depressed to a predetermined level, the upper edge of the associated guide 147 abuts or bottoms out on the bottom surface of front bracket 131 to prevent further deflection of that side of the forward portion 37 of chair bottom 6. In like manner, engagement between the lower edges of guides 147 and the horizontal legs 140 of brackets 137 and 138 prevents the associated side of chair bottom 6 from deflecting upwardly beyond a predetermined, maximum height. In one example of the present invention, a maximum deflection of 12.7 mm (1/2 inch) is achieved at the front edge of chair bottom 6 by virtue of spring 145.

The stiffness of spring 145 is selected so that the pressure necessary to deflect the forward portion 37 of chair bottom 6 downwardly is less than that which will result in an uncomfortable feeling or significantly disrupt the blood circulation in the legs of the user, which is typically considered to be caused by pressure of greater than approximately 3.5 to 7 kPa (1/2 to 1 pound per square inch). Hence, the forward portion 37 of chair bottom 6 is designed to move or adjust automatically and naturally as the user moves in the chair.

As explained in greater detail below, when the user applies sufficient pressure to the front portion 37 of chair bottom 6 to cause downward flexing of spring 145, not only does the front edge of chair bottom 6 move downwardly, but the entire chair bottom 6 rotates with respect to chair back 5 about synchrotilt axis 7. This unique tilting motion provides improved user comfort because the chair flexes naturally with the user's body, while at the same time maintains good support for the user's back. As discussed in greater detail below, the downward deflection of the front portion 37 of chair bottom 6 moves bearing pads 95 and 96 rearwardly over mating bearing surface 92, and causes the flex area 50 of chair 2 to bend a corresponding additional amount.

Front arm strap assembly 130 also permits the left-hand and right-hand sides of chair bottom 6 to flex or deflect vertically independent of each other, and independnet of control 3, as illustrated in Figs. 29 and 30, so that the chair automatically conforms with the shape and the movements of the seated user.

It is to be understood that the specific slide assembly 129 disclosed herein is not to be considered as the only mechanism contemplatd for achieving the claimed inventive concept, except insofar as the claims state otherwise. More specifically, the integrated chair and control arrangement contemplated and claimed in the present application does not require the front flexing motion achieved by spring 145. The present invention contemplates other slide assemblies 129, including those in which guides 147 are connected with the forward portion 37 of chair bottom 6 in other fashions, such as directly mounting guides 147 on chair bottom 6.

As best illustrated in Figs. 33-38, the slots 149 in guides 147 are slidingly received over the outwardly protruding tracks or rails 66 on control housing 8, and thereby permit the forward portion 37 of chair bottom 6 to move in a fore-to-aft direction with respect to control housing 8. Because the tracks are oriented along a generally downwardly opening arcuate path, rearward translation of the front portion 37 of chair bottom 6 allows the same to rotate in a counterclockwise direction with respect to control housing 8, and about bottom pivot axis 12, as described in greater detail below.

In the illustrated embodiment of the present invention chair shell 2a (Fig. 4) is attached to control 3 in the following manner. Bearing pads 95 and 96 are assembled onto the opposite ends of cross stretcher 91. Chair shell 2a is positioned over control 3, with the slots 45 (Fig. 14) on the rear side of chair back 5 aligned with uprights 76 ad 77. Rear arm strap 100 is adjusted on control 3, such that the mounting pads 55 (Fig. 13) on the lower surface of chair bottom 6 are received over mating fastener apertures 112 (Fig. 20) in the rear arm strap 100. Screws 126 are inserted through bearing pads 95 and 96, and secured in the threaded apertures

111 of rear arm strap 100. Front arm strap assembly 130 is temporarily supported on chair bottom 6, with the mounting pads 53 and 54 (Fig. 13) on the lower surface of chair bottom 6 positioned on the wings 133 and 134 of front bracket 131, and aligned with mating fastener apertures 161 (Fig. 21).

The slots 149 in guides 147 are then aligned with the rails 66 of control housing 8. Next, chair back 5 is pushed rearwardly, so that uprights 76 and 77 are closely received in the mating slots 46, and extend downwardly along the outermost pair of ribs 30. As best illustrated in Figs. 33-38, the "S" shape of chair shell 2a and uprights 75 and 76 is similar, so that the same mate closely together. Guides 147 are slidingly received on rails 66 to mount the forward portion 37 of chair bottom 6 on control 3. Four threaded fasteners 160 (Fig. 4) extend through mating apertures in upright straps 78 and 79, and are securely engaged in fastener nuts 25 mounted in chair back 5.

Bottom shell assembly 20 is then positioned in place below chair bottom 6. Threaded fasteners 163 (Fig. 4) are positioned through bottom shell assembly 20, and fastener apertures 161 in front bracket 131, and are securely engaged in the mating mounting pads 53 and 54 of chair bottom 6 to mount front arm strap assembly 130 on chair bottom 6. Threaded fasteners 162, 163 (Fig. 4) are positioned through bottom shell assembly 20, and the apertures 111 in rear arm strap 100, and are securely engaged in the mating mounting pads 55 of chair bottom 6 to mount the rearward portion 32 of chair bottom 6 on control 3.

When chair 2 is provided with arm assemblies 17, as shown in the illustrated example, the lower ends of the chair arms are positioned on the lower surface of chair bottom 6, and fasteners 162 and 163 extending through mating apertures in the same to attach arm assemblies 17 to the front and rear arm straps 100 and 131.

To best understand the kinematics of the present invention, reference is made to Figs. 31 and 32, which diagrammatically illustrate the motion of chair back 5 with respect to chair bottom 6. The pivot points illustrated in Figs. 31 and 32 are labelled to show the common axis 7, the back pivot axis 10, and the bottom pivot axis 12. It is to be understood that the kinematic model illustrated in Figs. 31 and 32 is not structurally identical to the preferred embodiments of the present invention as described and illustrated herein. This is particularly true insofar as the kinematic model illustrates chair bottom 6 as being pivoted about an actual bottom pivot axis 12 by an elongate arm, instead of the arcuate rails 66 and mating guides 147 of the preferred embodiment, which rotate chair bottom 6 about an imaginary bottom pivot axis 12. In any event, as the kinematic model illustrates, the rate at which chair back 5 tilts with respect to a stationary point is much greater than the rate at which chair bottom 6 rotates with respect to the same stationary point, thereby achieving a synchrotilt tilting action. In the illustrated kinematic model, rotation of chair back 5 about back pivot axis 10 by a set angular measure a causes chair bottom 6 to rotate about bottom pivot axis 12 by a different angular measure b. In the illustrated example, the relationship between chair back angle a and chair bottom angle b is approximately 2:1. Essentially pure rotation between chair back 5 and chair bottom 6 takes place about common axis 7. Pure rotation of chair back 5 takes place about back pivot axis 10. Chair bottom 6 both rotates and translates slightly to follow the motion of chair back 5. The 2:1 synchrotilt action is achieved by positioning bottom pivot axis 12 from common axis 7 a distance equal to twice the distance back pivot axis 10 is positioned from common axis 7. By varying this spatial relationship between common axis 7, back pivot axis 10 and bottom pivot axis 12, different synchrotilt rates can be achieved.

The kinematic model also shows the location of common axis 7 above chair bottom 6, and forward of chair back 5, at a point substantially coincident with or adjacent to the "H" point 13 of the user. As chair back 5 tilts rearwardly, common axis 7, along with the "H" point 13, rotate simultaneously about back pivot axis 10, along the arc illustrated in Fig. 32, thereby maintaining the adjacent spatial relationship between common axis 7 and the "H" point 13. Contemporaneously, chair bottom 6 and chair back 5 are rotating with respect to each other about the pivoting common axis 7 to provide synchrotilt chair movement. This combination of rotational motion provides a very natural and comfortable flexing action for the user, and also provides good back support, and alleviates shirt pull.

The kinematic model also illustrates the concept that in the present chair 2, hinges 52 are a part of shell 2a, not control 3. In prior art controls, the synchrotilt axis is defined by a fixed axle in the chair iron, and is therefore completely separate or independent from the supported shell. In the present invention, shell 2a and control 3 are integrated, wherein shell 2a forms an integral part of the articulated motion of chair 2.

With reference to Figs. 33-38, the kinematics of the preferred embodiment of the present invention will now be explained. In the fully upright, unoccupied position illustrated in Fig. 33, bearing pads 95 and 96 are oriented toward the forward edge of the bearing surface 93 on cross stretcher 91, and guides 147 are positioned near the forward edges of tracks 66. Spring 145 is fully curved and extended upwardly, such that the forward portion 37 of chair bottm 6 is in its fully raised condition, for the

upright position of chair 2. The broken lines, designated by reference number 155 in Fig. 33, illustrate the position of the front portion 37 of chair bottom 6 when the same is flexed fully downwardly.

Fig. 34 illustrates chair 4 in the fully upright position, but with a user seated on the chair 2. Fig. 34 shows an operational condition, wherein the user has applied some slight pressure to the forward portion 37 of chair bottom 6, so as to cause a slight downward deflection of the same. It is to be understood that the front portion 37 of chair bottom 6 need not be so deflected by every user, but that this movement will vary according to whatever pressure, if any, is applied to the forward portion of the chair by the individual user. This pressure will vary in accordance with the height and shape of the user, the height of both the chair 4 and any associated work surface, and other similar factors. In any event, the forward portion 37 of chair bottom 6 moves or deflects automatically in response to pressure applied thereto by the legs of the user, so as to alleviate any uncomfortable pressure and/or disruption of blood circulation in the user's legs, and to provide maximum adjustability and comfort. When the forward portion 37 of chair bottom 6 is deflected downwardly, bearing pads 95 and 96 move rearwardly over the upper bearing surface 93 of cross stretcher 91, and guides 147 move very slightly rearwardly along tracks 66, in the manner illustrated in Fig. 34. Hence, when the user exerts pressure on the forward portion 37 of chair bottom 6, not only does the front edge of the chair 2 drop or move downwardly, but the entire chair bottom 6 rotates about the common or synchrotilt axis 7, thereby providing improved user comfort and support. In one example of the present invention, maximum deflection of spring 145 causes chair bottom 6 to rotate approximately three degrees with respect to chair back 5 about synchrotilt axis 7, as shown by the imaginary planes identified by reference numerals 156 and 157 in Fig. 33.

Chair back 5 is tilted rearwardly by applying pressure or force thereto. Under normal circumstances, the user, seated in chair 4, tilts chair back 5 rearwardly by applying pressure to chair back 5, through force generated in the user's legs. When chair back 5 is tilted rearwardly, because back pivot axis 10 is located under the central or medial porton of chair bottom 6, the entire chair back 5, as well as the rearward portion 31 of chair bottom 6 move downwardly and rearwardly as they rotate about back pivot axis 10. In the illustrated example, the amount of such downward movement is rather substantial, in the nature of 51 to 102 mm (2 to 4 inches). This motion pulls the forward portion 37 of chair bottom 6 rearwardly, causing guides 147 to slide rearwardly over tracks 66. Since tracks 66 are in the shape of downwardly facing arcs, as chair back 5 is tilted rearwardly, the forward portion 37 of chair bottom 6 moves downwardly and rearwardly along an arcuate path. The downward and rearward movement of chair shell 2a also pulls bearing pads 95 and 96 slidingly rearwardly over the upper bearing surface 93 of cross stretcher 91. The upwardly opening, arcuate shape of bearing surface 93 and mating pads 95 and 96 causes the rearward portion 31 of chair bottom 6 to rotate with respect to chair back 5 in a clockwise direction, as viewed in Figs. 33-38. The resultant motion of shell 2a is that chair back 5 rotates with respect to chair bottom 6 about common axis 7 to provide a comfortable and supportive synchrotilt action. As chair back 5 tilts rearwardly, synchrotilt axis 7 rotates simultaneously with chair back 5 about an arc having its centre coincident with back pivot axis 10. In the illustrated example, when chair 2 is occupied by an average user, synchrotilt axis 7 is located approximately 38 mm (1-1/2 inches) above the supporting comfort surface 158 of chair bottom 6, and approximately 89 mm (3-1/2 inches) forward of the plane of supporting comfort surface 158 of chair back 5. The plane of supporting comfort surface 158 of chair back 5 is illustrated by the broken line in Fig. 6 identified by the reference numeral 153, and the exemplary distance specified above is measured along a horizontal line between synchrotilt axis 7 and back plane 153. Thus, synchrotilt axis 7 is located adjacent to, or within the preferred window or range of the empirically derived "H" point.

As best illustrated in Fig. 37, in the rearwardly tilted position, the forward portion 37 of chair bottom 6 can be deflected downwardly by virtue of spring 145. When spring 145 is deflected fully downwardly, in the position shown in dotted lines noted by reference numeral 155, bearing pads 95 and 96 assume their rearwardmost position on the upper bearing surface 93 of cross stretcher 91, and guides 147 move to their rearwardmost position on tracks 166. It is to be noted that by virtue of the front deflection available through spring 145, the user can realize substantially no lifting action at all at the front edge of chair bottom 6, so that chair bottom 6 does not exert undesirable pressure on the user's thighs, and the user's feet are not forced to move from the position which they assume when the chair is in the fully upright position. In other words, in the illustrated example, the amount of rise experienced at the forward edge of chair bottom 6 by virtue of tilting chair back 5 fully rearwardly is substantially equal to the maximum vertical movement achievable through spring 145.

With reference to Fig. 37, the broken lines identified by reference numeral 165 illustrate the position of the forward portion 37 of seat bottom 6 when chair 2 is in the fully upright position, and

forward seat portion 37 is in its fully raised, undeflected position. The broken lines identified by the reference numeral 166 in Fig. 37 illustrate the position of the forward portion 37 of seat bottom 6 when chair 2 is fully upright, and the forward seat portion 37 is in its fully lowered, deflected position.

As chair back 5 is tilted rearwardly, living hinges 52 bend, and flex area 50 deflects to permit mutual rotation of chair back 5 with respect to chair bottom 6 about common axis 7. As best illustrated in Fig. 11, when chair back 5 is in the fully upright position, slots 46 are fully open, with the width of each slot being substantially uniform along its length. As chair back 5 tilts rearwardly, the rearward edges of slots 46 tend to fold under the corresonding forward edge of the slot to close the same slightly, and distort their width, particularly at the centre portion of the flex area 50, as shown in Fig. 12. Flex area 50 is quite useful in holding the back 5 and bottom 6 portions of chair shell 2a together before chair shell 2a is assembled on control 3.

Chair shell ribs 30 and 45, along with uprights 76 and 77, provide substantially rigid support along the spine area of the chair shell 2a, yet permit lateral flexing of the upper portion 34 of chair back 5, as illustrated in Figs. 8 and 9, so as to provide the user with improved freedom of movement in the upper portion of his body.

Integrated chair and control 1 permits chair 2 to flex in a natural fashion in response to the shape and the motions of the user's body, and threby optimizes comfort in each and every chair position. Chair 2 incorporates a unique blend of mechanics and aesthetics, which imitate both the contour of the user's body and the movement of the user's body. Control 3 ensures that the major rearward tilting motion of chair 4 is fully controlled in accordance with predetermined calculations to give the chair a safe and secure feel, and also to properly support the user's body in a good posture. The common or synchrotilt axis 7 is located ergonomically, adjacent to the hip joints, or "H" point of the seated user to provide improved comfort. When chair back 5 is tilted rearwardly, chair back 5, along with at least a portion of chair bottom 6, shift generally downwardly in a manner which simultaneously shifts the location of common axis 7 along a path which maintains its adjacent spatial relationship with the user's hip joints. As a result of this unique tilting action, improved lumbar support is achieved, and shirt pull is greatly alleviated.

Chair shell 2a and control 3 interact as a unitary, integrated support member for the user's body, which senses the shape and movement of the user's body, and reacts naturally thereto, while providing improved postural support.

## Claims

1. A chair comprising a base (4), a chair back (5), a chair bottom (6), a control (3) comprising means (80,82) for supporting the chair back on the base permitting rearward tilting of the chair back, means for movably supporting the chair bottom on the base, whereby rearward tilting of the chair back simultaneously shifts the chair bottom and means interconnecting the chair back and the chair bottom for rotation about a common axis (7) with respect to each other, the common axis being located above the chair bottom, forward of the chair back (5), characterised in that during tilting of the chair back, the common axis (7) is maintained in a position fixed relative to each of the chair back and bottom respectively and spatially adjacent to the axis of the hip joints (13) of a model seated user.

2. A chair according to claim 1 in which the control comprises an upwardly opening, arcuately shaped bearing support surface 90 disposed on one of the control 3 and the chair bottom 6; and a bearing 95,96 connected with the other of the control 3 and the chair bottom 6, having an arcuately shaped surface matingly engaging the bearing support surface for sliding motion therebetween.

3. A chair according to claim 2 in which the chair bottom 6 includes a forward portion and a rearward portion 31; the bearing 95,96 is connected with the rearward portion 31 of the chair bottom; and the bearing support surface 92 is disposed on the chair back connecting means 80, 81, and moves therewith, whereby rearward tilting of the chair back simultaneously shifts the chair back, and at least a portion of the rearward portion of the chair bottom downwardly.

4. A chair according to claim 2 or claim 3 in which the chair back has a normal, fully upright position, and the bearing support surface 90 includes a longitudinal centreline disposed generally vertically aligned with said common axis 7 when said chair back is in the fully upright position.

5. A chair according to claim 2 or claim 3 or claim 4 in which the bearing support surface 90 lies along an arc which is substantially concentric with the said common axis 7.

6. A chair according to any of claims 1 to 5 in which the chair back supporting means com-

prises means 64,65,83,84 for pivotally connecting the chair back 5 with the base 4 for rotation about a back pivot axis I0.

7. A chair according to claim 6 in which the back pivot axis I0 is positioned in a predetermined relationship with the chair back 5, whereby rearward tilting of the chair back shifts the chair back generally downwardly.

8. A chair according to any of claims I to 6 in which the chair bottom supporting means comprises a slide I37, I47, 66 connecting the forward portion of the chair bottom 6 with the base 4 to permit fore-to-aft movement therebetween.

9. A chair according to claim 8 in which the slide includes means for rotating the forward portion of said chair bottom 6 downwardly about a bottom pivot axis I2 when the chair back 5 is tilted rearwardly.

10. A chair according to claim 9 which includes means for rotating said chair back about the back pivot axis at a rate greater than the rate at which said chair bottom rotates about said bottom pivot axis to provide synchrotilt chair movement.

11. A chair according to claim 8 or claim 9 or claim I0 in which the slide includes at least one track 66 supported on the base 4; and at least one guide I47 connected with the forward portion of the chair bottom 6, and slidingly engaging the track for translation therealong.

12. A chair according to claim II in which the track 66 has a generally downwardly opening, arcuate shape, which permits the forward portion of the chair bottom 6 to move along a predetermined arcuate path when the chair back 5 is tilted rearwardly to define at least a portion of said chair bottom rotating means.

13. A chair according to claim I2 which includes a spring I45 connecting the guide I47 with the chair bottom 6, and permitting the forward portion of the chair bottom 6 to move upwardly and downwardly independent of the chair bottom supporting means to alleviate undesirable pressure on the legs of the user.

14. A chair according to claim I3 which includes means I50, I5I for connecting the spring I45 to the guide I47 in a manner which transmits fore-to-aft translation therebetween, whereby downward movement of the forward portion of said chair bottom rotates the entire chair bottom about said common axis for improved user comfort.

15. A chair according to claim I3 or claim I4 in which the spring I45 is mounted in a manner to permit opposite sides of the forward portion of the chair bottom 6 to deflect independently in a vertical direction for improved user comfort.

16. A chair according to claim I3 or claim I4 or claim I5 in which the spring I45 comprises a leaf spring oriented transversely across the forward portion of the chair bottom 6.

17. A chair according to any of claims II to I6 which includes a control housing 8 supported on the base 4; a pair of said tracks 66 mounted on opposite sides of the housing, and a pair of said guides I47 connected with said chair bottom 6 at opposite sides thereof, and slidingly engaging said tracks for translation therealong.

18. A chair according to any of claims 1 to 17 which includes a moulded, one-piece, unitary shell 2a, with a living hinge 52 disposed therein between the chair back 5 and the chair bottom 6 to define the said common axis 7.

19. A chair according to claim 18 in which the chair back 5 includes an upper portion 34 and a lower portion 33 and the shell 2a includes at least one generally vertically oriented rib 30 extending between the rearward portion 31 of the chair bottom 6, and the lower portion 33 of the chair back 5 to rigidify the same in a vertical plane, yet permit the upper portion 34 of the chair back 5 to flex slightly in a horizontal plane.

**Revendications**

1. Siège comportant une embase (4), un dossier de siège (5), une partie inférieure de siège (6), un organe de commande (3) qui comprend des moyens (80,82) pour supporter le dossier du siège sur l'embase tout en permettant au dossier du siège de s'incliner vers l'arrière, des moyens pour supporter, de façon amovible, la partie inférieure du siège sur l'embase, étant précisé que le fait que le dossier du siège s'incline vers l'arrière décale simultanément la partie inférieure du siège, et des moyens interconnectant le dossier du siège et la partie inférieure du siège pour permettre leur rotation autour d'un axe commun (7) l'un par rapport à l'autre, l'axe commun étant situé

au-dessus de la partie inférieure du siège et en avant du dossier du siège (5), siège caractérisé par le fait qu'au cours de l'inclinaison du dossier du siège, l'axe commun (7) est maintenu en position fixe par rapport, respectivement, à l'un et à l'autre, du dossier du siège et de la partie inférieure du siège, et qu'il se trouve, dans l'espace, voisin de l'axe des jointures de hanche (13) d'un utilisateur assis servant de modèle.

2. Siège selon la revendication 1, dans lequel l'organe de commande comporte une surface support formant portée 90, en forme d'arc ouvert vers le haut, disposée sur l'un des deux, de l'organe de commande 3 et de la partie inférieure du siège 6; ainsi que des supports 95, 96 reliés avec l'autre des deux, de l'organe de commande 3 et de la partie inférieure du siège 6, et présentant une surface en forme d'arc qui vient en prise associée avec la surface support formant portée pour permettre un mouvement de coulissement entre eux.

3. Siège selon la revendication 2, dans lequel la partie inférieure du siège 6 comporte une portion avant et une portion arrière 31; dans lequel les supports 95,96 sont reliés à la portion arrière 31 de la partie inférieure du siège; et dans lequel la surface support formant portée 92 est disposée sur les moyens 80,81 reliant le dossier du siège et se déplace avec eux, ce par quoi l'inclinaison, vers l'arrière, du dossier du siège décale simultanément le dossier du siège et, vers le bas, au moins une portion de la portion arrière de la partie inférieure du siège.

4. Siège selon la revendication 2 ou la revendication 3, dans lequel le dossier du siège a une position normale entièrement verticale et dans lequel la surface support formant portée 90 présente un axe géométrique longitudinal disposé de façon générale verticalement aligné avec ledit axe commun 7 lorsque ledit dossier du siège se trouve dans la position entièrement verticale.

5. Siège selon la revendication 2 ou la revendication 3 ou la revendication 4, dans lequel la surface support formant portée 90 est située selon un arc qui est substantiellement concentrique avec ledit axe commun 7.

6. Siège selon l'une quelconque des revendications 1 à 5, dans lequel les moyens supportant le dossier du siège comportent des moyens 64,65,83,84 pour relier, avec liberté de pivotement, le dossier du siège 5 avec l'embase 4 pour permettre la rotation du dossier du siège autour de l'axe 10 de pivotement du dossier du siège.

7. Siège selon la revendication 6, dans lequel l'axe 10 de pivotement du dossier du siège est positionné en relation prédéterminée avec le dossier du siège 5, ce par quoi le fait d'incliner vers l'arrière le dossier du siège décale le dossier du siège, de façon générale, vers le bas.

8. Siège selon l'une quelconque des revendications 1 à 6, dans lequel les moyens supportant la partie inférieure du siège comportent un organe de coulissement 137,147,66 qui relie la portion avant de la partie inférieure du siège 6 avec l'embase 4 pour permettre un mouvement de l'avant vers l'arrière entre eux.

9. Siège selon la revendication 8, dans lequel l'organe de coulissement comporte des moyens pour faire tourner la portion avant de ladite partie inférieure du siège 6 vers le bas autour d'un axe 12 de pivotement de la partie inférieure du siège lorsque le dossier du siège 5 s'incline vers l'arrière.

10. Siège selon la revendication 9, comportant des moyens pour faire tourner ledit dossier du siège autour de l'axe de pivotement du dossier du siège à une vitesse supérieure à la vitesse avec laquelle ladite partie inférieure du siège tourne autour dudit axe de pivotement de la partie inférieure du siège, pour réaliser un mouvement du siège en inclinaison synchrone.

11. Siège selon la revendication 8 ou la revendication 9 ou la revendication 10, dans lequel l'organe de coulissement comporte au moins un rail 66 supporté sur l'embase 4; et au moins un guide 147 relié à la portion avant de la partie inférieure du siège 6 et venant en prise, avec liberté de coulissement, avec le rail pour opérer une translation le long de ce rail.

12. Siège selon la revendication 11, dans lequel le rail 66 présente de façon générale une forme en arc ouvert vers le bas qui permet à la portion avant de la partie inférieure du siège 6 de se déplacer le long d'un chemin en arc prédéterminé lorsque le dossier du siège 5 s'incline vers l'arrière pour définir au moins une portion desdits moyens de rotation de la partie inférieure du siège.

13. Siège selon la revendication 12, comportant un

ressort 145 qui relie le guide 147 avec la partie inférieure du siège 6 et qui permet à la portion avant de la partie inférieure du siège 6 de se déplacer vers le haut et vers le bas, indépendamment des moyens qui supportent la partie inférieure du siège, pour alléger la pression indésirable sur les jambes de l'utilisateur.

14. Siège selon la revendication 13, comportant des moyens 150,151 pour relier le ressort 145 au guide 147 d'une façon qui transmet une translation, de l'avant vers l'arrière, entre eux, ce par quoi le mouvement, vers le bas, de la portion avant de ladite partie inférieure du siège entraine en rotation la totalité de la partie inférieure du siège autour dudit axe commun pour un confort amélioré de l'utilisateur.

15. Siège selon la revendication 13 ou la revendication 14 dans lequel le ressort 145 est monté de façon à permettre aux côtés opposés de la portion avant de la partie inférieure du siège 6 de fléchir indépendamment en direction verticale pour un confort amélioré de l'utilisateur.

16. Siège selon la revendication 13 ou la revendication 14 ou la revendication 15, dans lequel le ressort 145 est constitué d'un ressort à lame orienté transversalement par rapport à la portion avant de la partie inférieure du siège 6.

17. Siège selon l'une quelconque des revendications 11 à 16, comportant un carter 8 de l'organe de commande supporté sur l'embase 4; une paire desdits rails 66 montés des côtés opposés du carter, et une paire desdits guides 147 reliés avec ladite partie inférieure du siège 6 à ses côtés opposés et venant en prise coulissante avec les rails pour opérer une translation le long des rails.

18. Siège selon l'une des revendications 1 à 17 comportant une coque moulée d'une seule pièce, avec une charnière souple 52 qui y est disposée entre le dossier du siège 5 et la partie inférieure du siège 6 pour définir ledit axe commun 7.

19. Siège selon revendication 18, dans lequel le dossier du siège 5 comporte une portion supérieure 34 et une portion inférieure 33 et dans lequel la coque 2a comporte au moins une nervure 30 qui est orientée de façon générale verticalement et qui s'étend entre la portion arrière 31 de la partie inférieure du siège 6 et la portion inférieure 33 du dossier du siège 5 pour rigidifier ce dossier dans un plan vertical tout en permettant à la portion supérieure 34 du dossier du siège 5 de fléchir légèrement dans un plan horizontal.

## Patentansprüche

1. Stuhl mit einer Basis (4), einer Rückenlehne (5), einer Sitzfläche (6), einer Bedienungsvorrichtung (3), die Vorrichtungen (80, 82) zum Stützen der Rückenlehne an der Basis aufweist, die ein Hinterkippen der Stuhllehne erlauben, Vorrichtungen zum beweglichen Stützen der Sitzfläche auf der Basis, wodurch ein Hinterkippen der Rückenlehne ein gleichzeitiges Verschieben der Sitzfläche bewirkt, und Vorrichtungen, die die Rückenlehne und die Sitzfläche miteinander verbinden, für die gegenseitige Drehbewegung um eine gemeinsame Achse (7), wobei sich die gemeinsame Achse über der Sitzfläche vor der Rückenlehne (5) befindet, **dadurch gekennzeichnet, daß** die gemeinsame Achse (7) beim Hinterkippen der Rückenlehne jeweils in einer festen Position zur Rückenlehne bzw. zur Sitzfläche und räumlich benachbart zur Achse der Hüftgelenke (13) einer auf dem Stuhl sitzenden Person verbleibt.

2. Stuhl nach Anspruch 1, **dadurch gekennzeichnet, daß** die Bedienungsvorrichtung eine sich nach oben öffnende, exakt geformte Lagerstützfläche (90), die entweder auf der Bedienungsvorrichtung (3) oder der Sitzfläche (6) angeordnet ist, und ein Lager (95, 96) umfaßt, das mit dem jeweils anderen Teil, d.h. der Bedienungsvorrichtung (3) oder der Sitzfläche (6), verbunden ist, mit einer exakt geformten Oberfläche, die für eine gegenseitige Gleitbewegung formschlüssig mit der Lagerstützfläche korreliert.

3. Stuhl nach Anspruch 2, **dadurch gekennzeichnet, daß** die Sitzfläche (6) einen vorderen Bereich und einen rückwärtigen Bereich (31) umfaßt, daß das Lager (95, 96) mit dem rückwärtigen Bereich (31) der Sitzfläche verbunden ist, und daß die Lagerstützfläche (92) bei den Verbindungsvorrichtungen (80, 81) der Rückenlehne angeordnet ist und sich zusammen damit bewegt, wodurch ein Hinterkippen der Rückenlehne ein gleichzeitiges Verschieben der Sitzfläche und wenigstens eines Teils des rückwärtigen Bereichs der Sitzfläche nach unten bewirkt.

4. Stuhl nach Anspruch 2 oder 3, **dadurch gekennzeichnet, daß** der Stuhl eine normale, völlig aufgerichtete Stellung hat und daß die Lagerstützfläche (90) einen Längsmittellinie

aufweist, die im wesentlichen vertikal zu der gemeinsamen Achse (7) ausgerichtet ist, wenn sich die Rückenlehne in der völlig aufgerichteten Stellung befindet.

5. Stuhl nach Anspruch 2, 3 oder 4, **dadurch gekennzeichnet, daß** die Lagerstützfläche (90) entlang eines Bogens liegt, der im wesentlichen konzentrisch zur gemeinsamen Achse (7) ist.

6. Stuhl nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, daß** die Stützvorrichtung der Rückenlehne Vorrichtungen (64, 65, 83, 84) zum schwenkbaren Verbinden der Rükkenlehne (5) mit der Basis (4) für eine Drehbewegung um eine Lehnenschwenkachse (10) umfaßt.

7. Stuhl nach Anspruch 6, **dadurch gekennzeichnet, daß** die Lehnenschwenkachse (10) in einer vorgegebenen Beziehung zur Rückenlehne (5) angeordnet ist, wodurch ein Hinterkippen der Rückenlehne ein gleichzeitiges Verschieben der Rückenlehne im wesentlichen nach unten bewirkt.

8. Stuhl nach einem der Ansprüche 1 bis 6, **dadurch gekennzeichnet, daß** die Sitzflächenstützeinrichtung ein Gleitelement (137, 147, 66) aufweist, das den vorderen Bereich der Sitzfläche (6) mit der Basis (4) verbindet, um eine Vorwärts/Rückwärts-Bewegung dazwischen zu erlauben.

9. Stuhl nach Anspruch 8, **dadurch gekennzeichnet, daß** das Gleitelement eine Vorrichtung zum Drehen des vorderen Bereichs der Sitzfläche (6) nach unten um eine Sitzflächenschwenkachse (12) aufweist, wenn die Rückenlehne (6) nach hinten gekippt ist.

10. Stuhl nach Anspruch 9, **dadurch gekennzeichnet, daß** er eine Vorrichtung zum Drehen der Rückenlehne um eine Lehnenschwenkachse in einem Maße, stärker als das, mit dem die Sitzfläche um die Sitzflächenschwenkachse gedreht wird, um eine synchrone Bewegung beim Hinterkippen zu gewährleisten.

11. Stuhl nach Anspruch 8, 9 oder 10, **dadurch gekennzeichnet, daß** das Gleitelement wenigstens eine auf der Basis (4) gelagerte Spur (66) und wenigstens eine Führung (147) umfaßt, die mit dem vorderen Bereich der Sitzfläche (6) verbunden ist und in Gleitverbindung mit der Spur für eine Translationsbewegung entlang dieser korreliert.

12. Stuhl nach Anspruch 11, **dadurch gekennzeichnet, daß** die Spur (66) eine sich im wesentlichen nach unten öffnende, exakte Form hat, die erlaubt, daß sich der vordere Bereich der Sitzfläche (6) entlang eines vorgegebenen genauen Wegs bewegt, wenn die Rückenlehne (5) nach hinten gekippt wird, um wenigstens einen Teil der Sitzflächendrehvorrichtung zu definieren.

13. Stuhl nach Anspruch 12, **dadurch gekennzeichnet, daß** er eine Feder (145) umfaßt, die die Führung (147) mit der Sitzfläche (6) verbindet und erlaubt, daß sich der vordere Bereich der Sitzfläche (6) unabhängig von der Sitzflächenstützvorrichtung nach oben oder nach unten bewegt, um eine unerwünschte Belastung der Beine des Benutzers auszugleichen.

14. Stuhl nach Anspruch 13, **dadurch gekennzeichnet, daß** er Vorrichtungen (150, 151) zum Verbinden der Feder (145) mit der Führung (147) umfaßt, so daß eine Vorwärts/Rückwärtsbewegung dazwischen übertragen wird, was dazu führt, daß eine nach unten gerichtete Bewegung des vorderen Bereichs der Sitzfläche zur Verbesserung des Sitzkomforts die gesamte Sitzfläche um die gemeinsame Achse nach unter dreht.

15. Stuhl nach Anspruch 13 oder 14, **dadurch gekennzeichnet, daß** die Feder (145) so angebracht ist, daß es möglich ist, daß gegenüberliegende Seiten des vorderen Bereichs der Sitzfläche (6) unabhängig in einer vertikalen Richtung umzubiegen, um den Sitzkomfort zu verbessern.

16. Stuhl nach Anspruch 13, 14 oder 15, **dadurch gekennzeichnet, daß** die Feder (145) eine Blattfeder umfaßt, die quer über den vorderen Bereich der Sitzfläche (6) ausgerichtet ist.

17. Stuhl nach einem der Ansprüche 11 bis 16, **dadurch gekennzeichnet, daß** er ein Gehäuse (8) für die Bedienungsvorrichtung, welches auf der Basis (4) gelagert ist, ein Paar der Spuren (66), die auf gegenüberliegenden Seiten des Gehäuses angebracht sind, und ein Paar der Führungen (147) aufweist, die auf gegenüberliegenden Seiten der Sitzfläche (6) mit derselben verbunden sind und für eine Translationsbewegung entlang der Spuren in gleitender Verbindung mit denselben stehen.

18. Stuhl nach einem der Ansprüche 1 bis 17,

**dadurch gekennzeichnet, daß** er eine gegossene, einstückige, einheitliche Schale (2a) umfaßt, wobei ein mitgehendes Gelenkelement (52) darin zwischen der Rückenlehne (5) und der Sitzfläche (6) angeordnet ist, um die gemeinsame Achse (7) zu definieren.

19. Stuhl nach Anspruch 18, **dadurch gekennzeichnet, daß** die Rückenlehne (5) einen oberen Bereich 34 und einen unteren Bereich 33 aufweist und daß die Schale 2a wenigstens eine im wesentlichen vertikal ausgerichtete Rippe (30) hat, die sich zwischen dem rückwärtigen Bereich (31) der Sitzfläche (6) und dem unteren Bereich (33) des Rückenlehne (5) erstreckt, um denselben in einer vertikalen Ebene zu verstärken und dennoch ein leichtes Abbiegen des oberen Bereichs (34) der Rükkenlehne (5) in einer horizontalen Ebene zu erlauben.

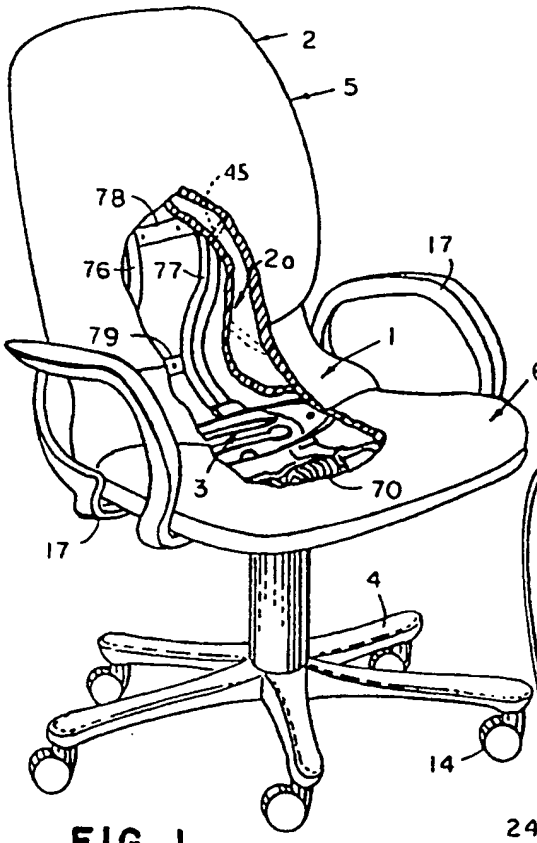



FIG. 1

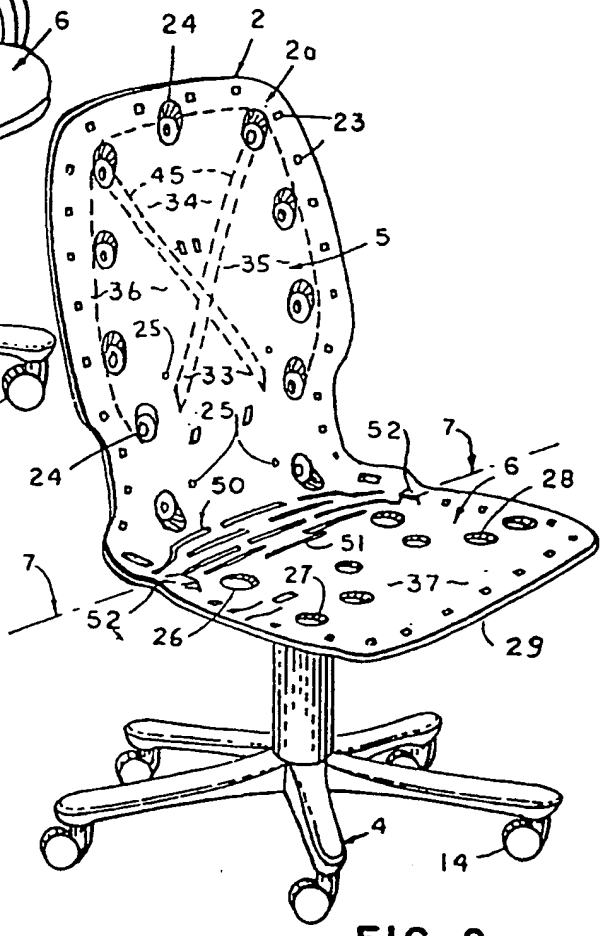
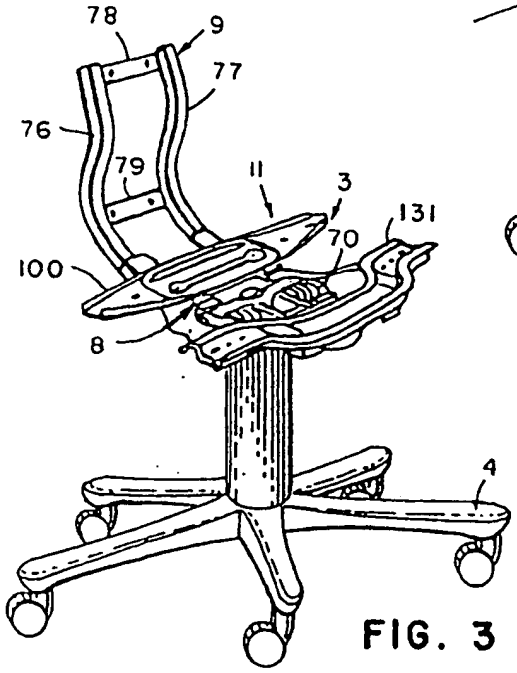



FIG. 2

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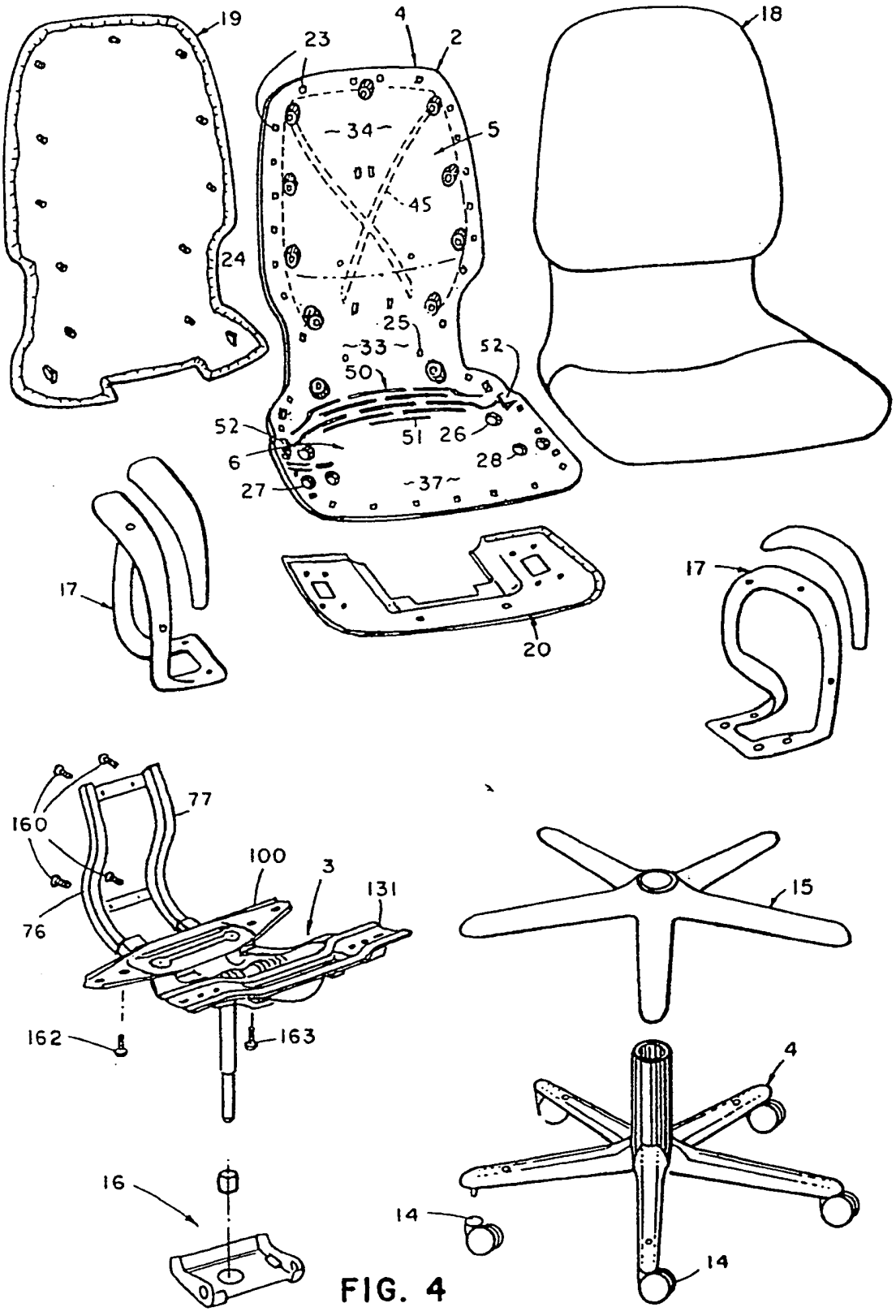
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FIG. 4

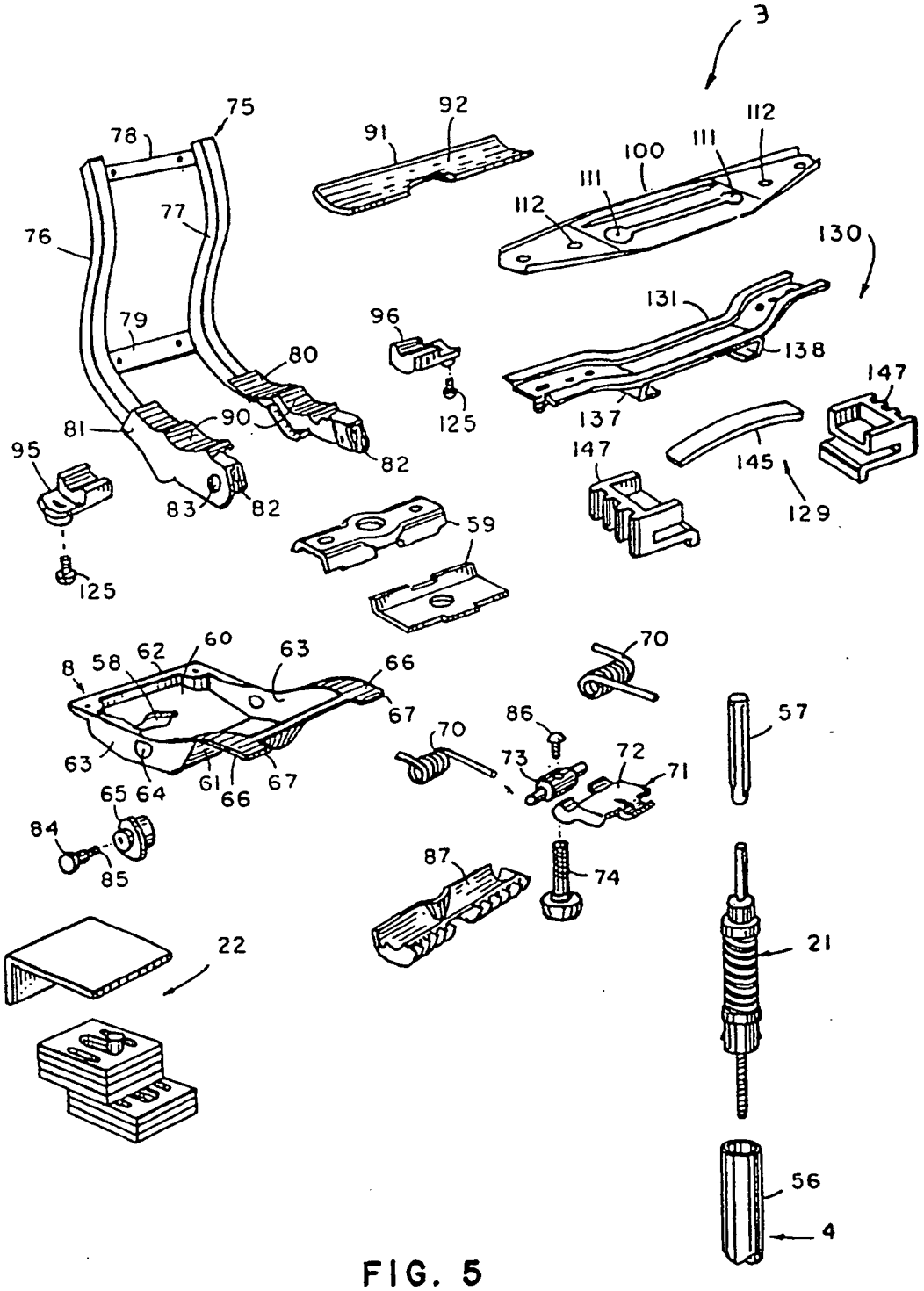
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FIG. 5

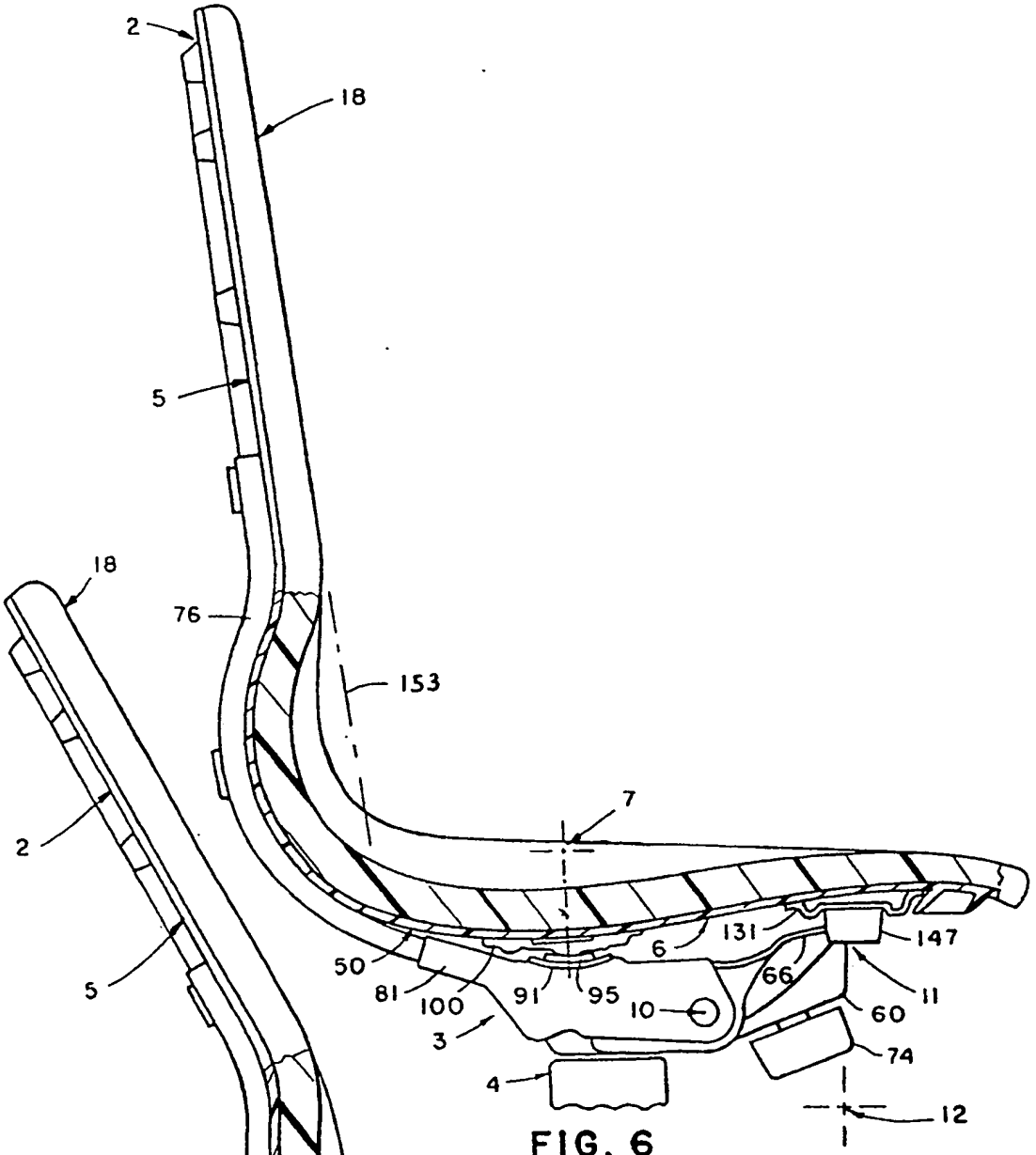
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FIG. 6

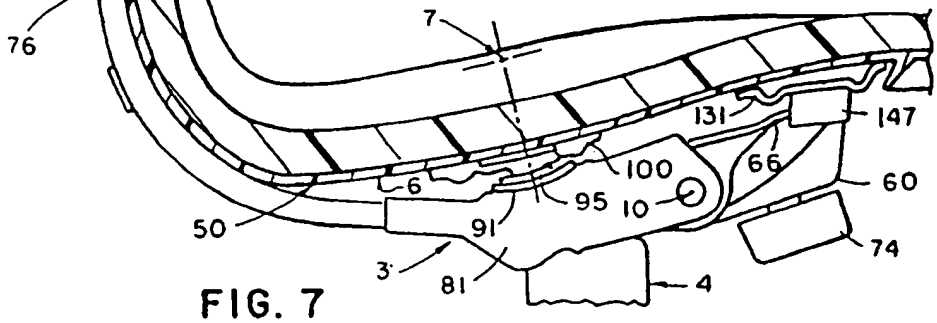
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FIG. 7

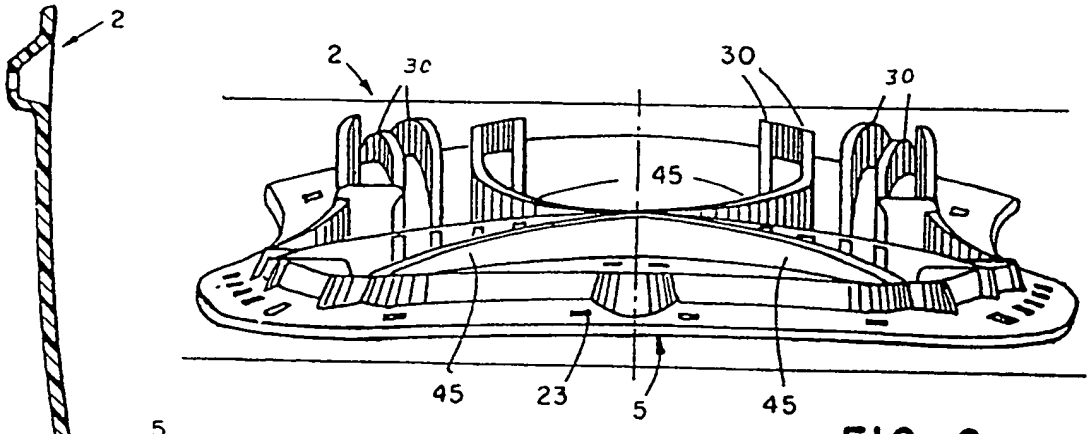


FIG. 8

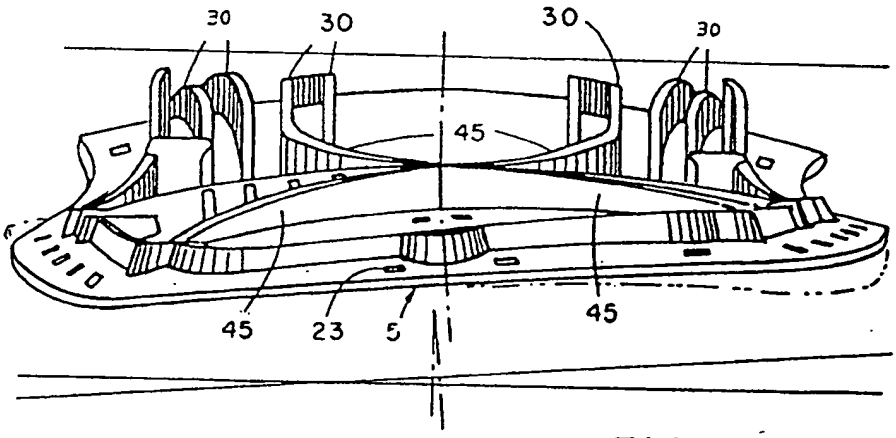


FIG. 9




FIG. 10

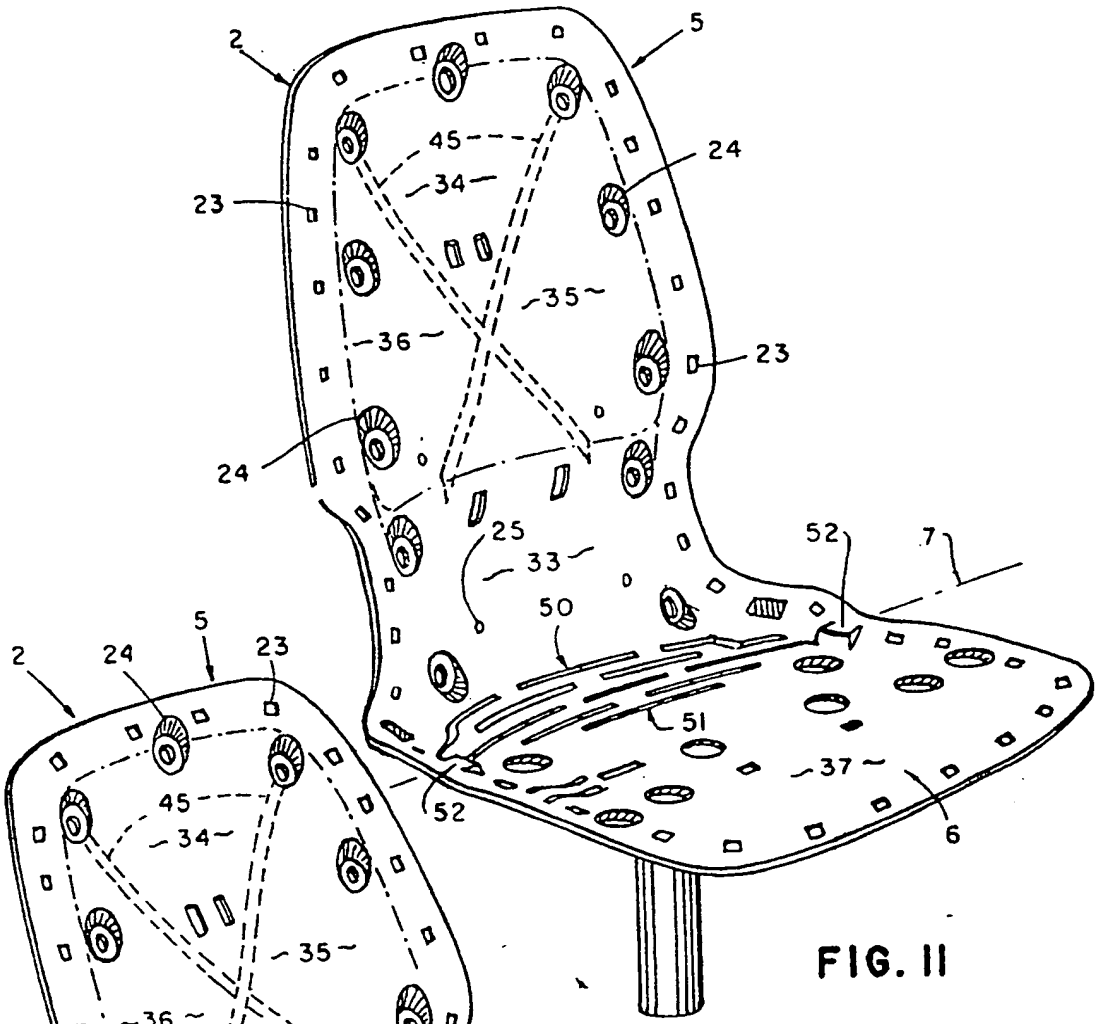
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FIG. 11

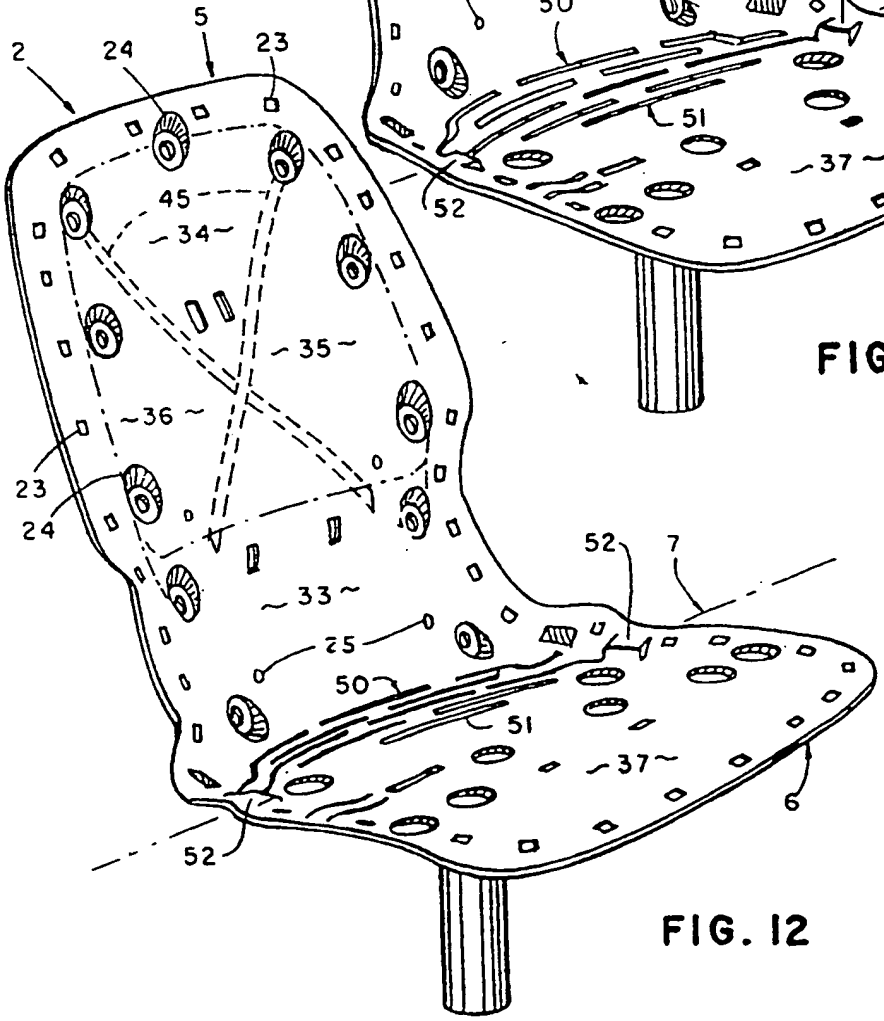
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FIG. 12

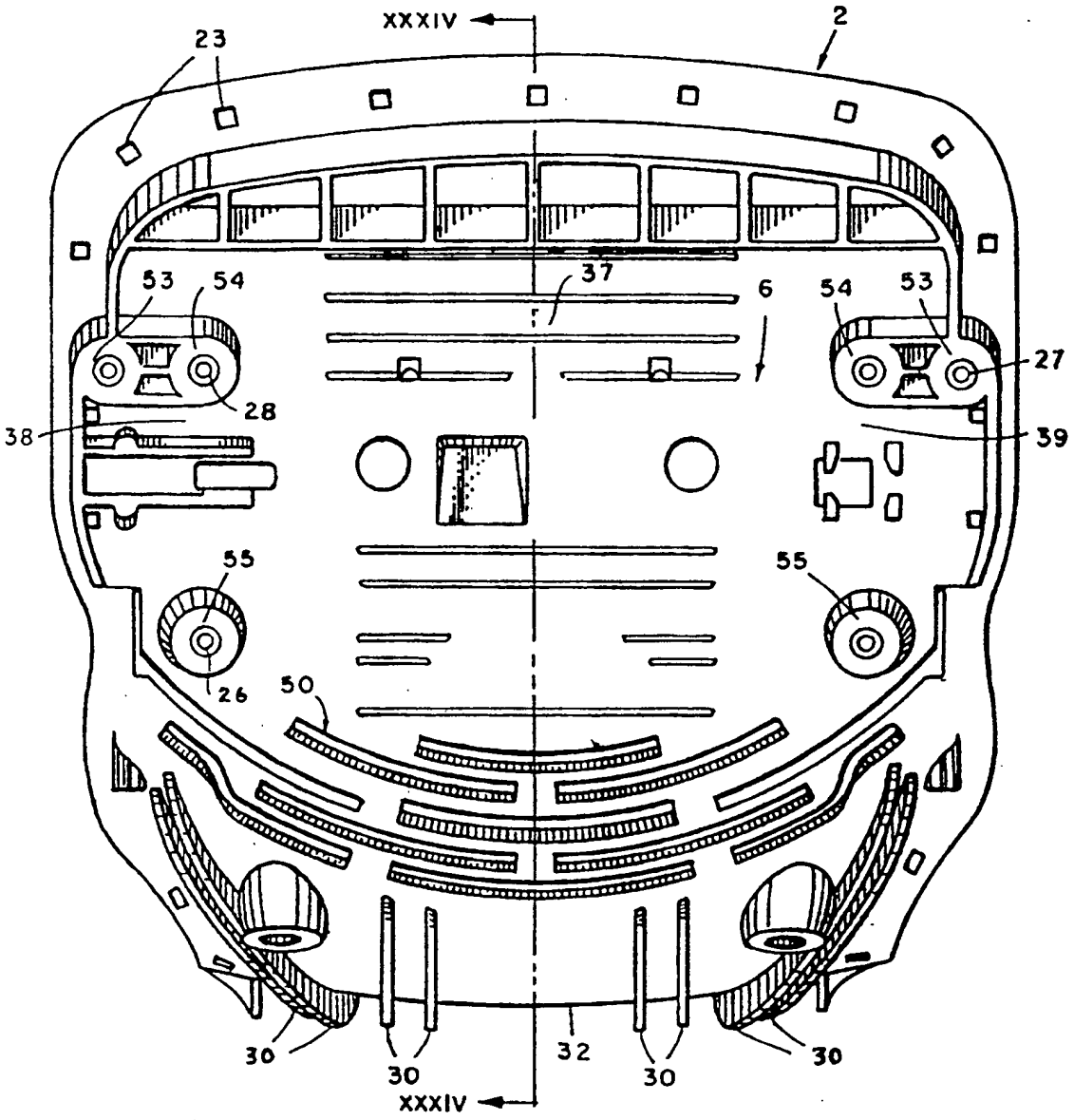
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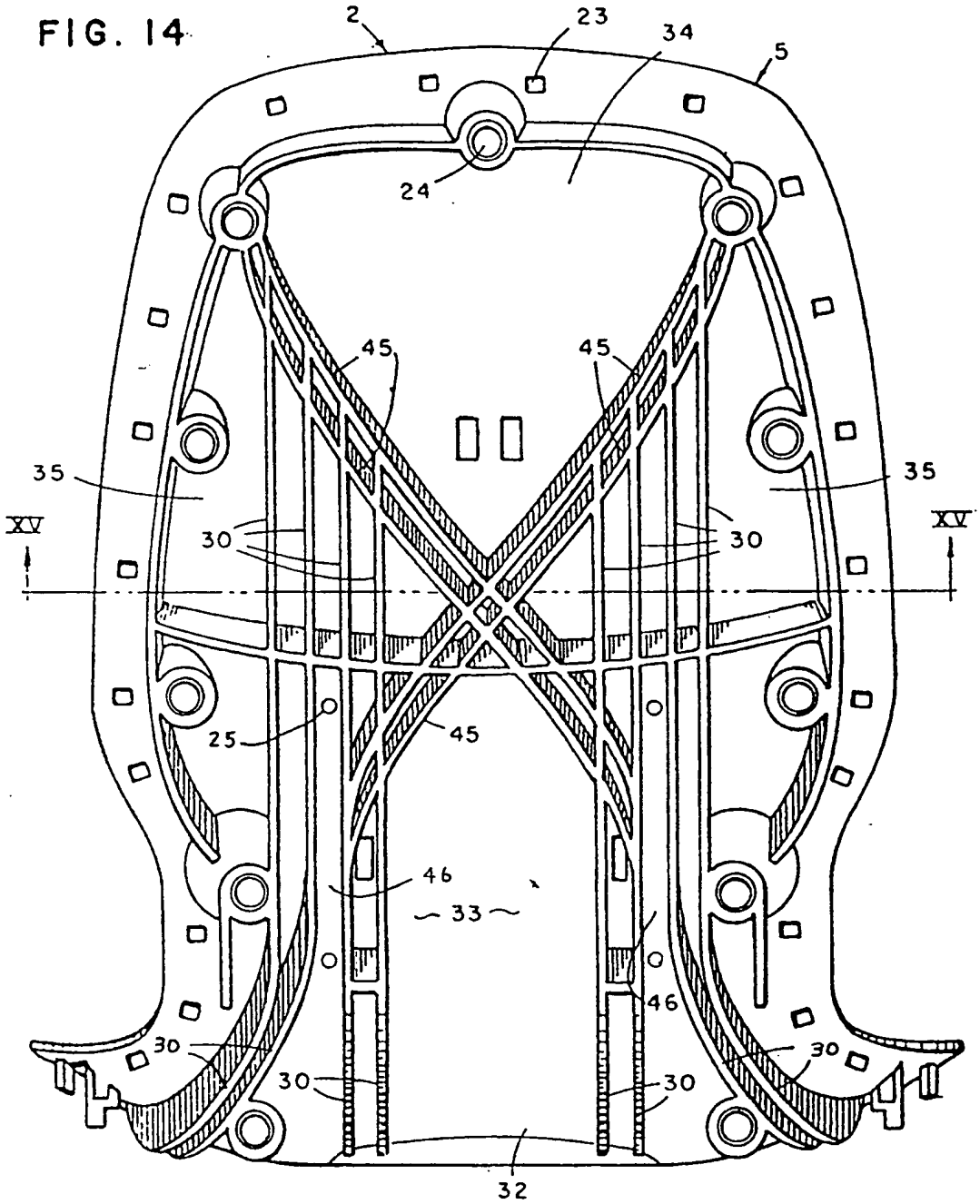
FIG. 13

FIG. 14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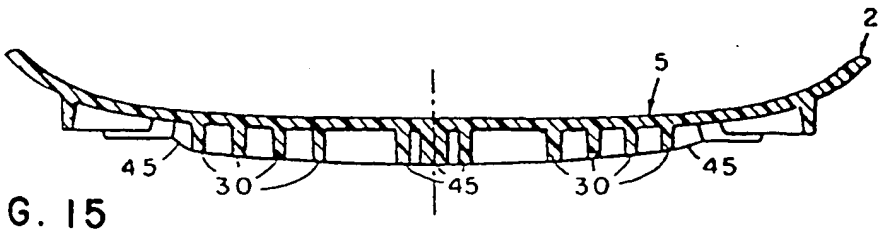
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FIG. 15

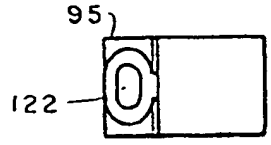



FIG. 17

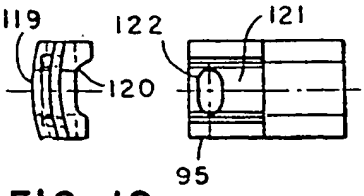



FIG. 18

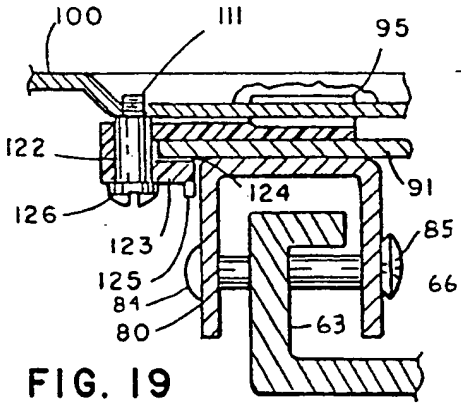



FIG. 19

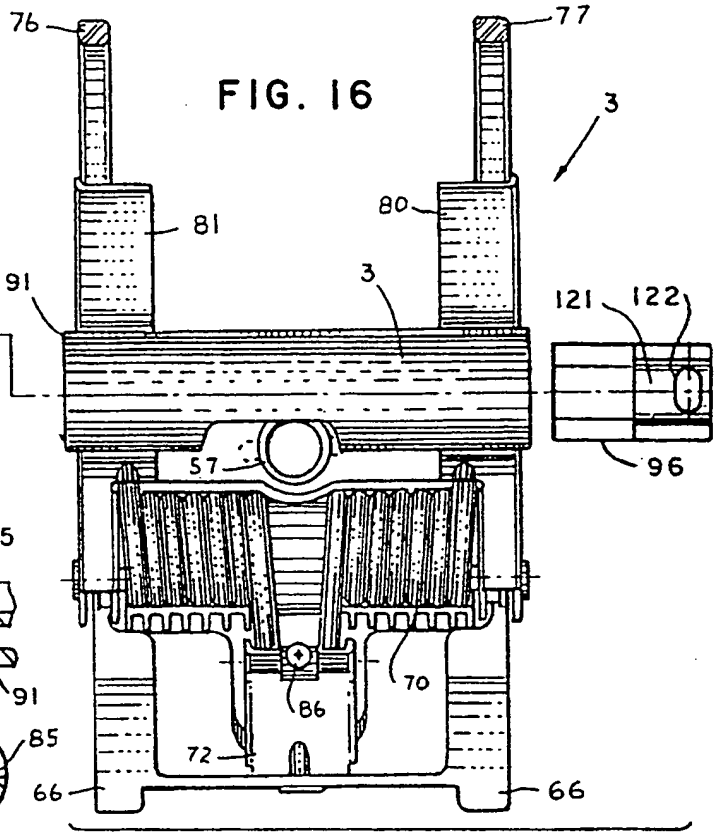



FIG. 16

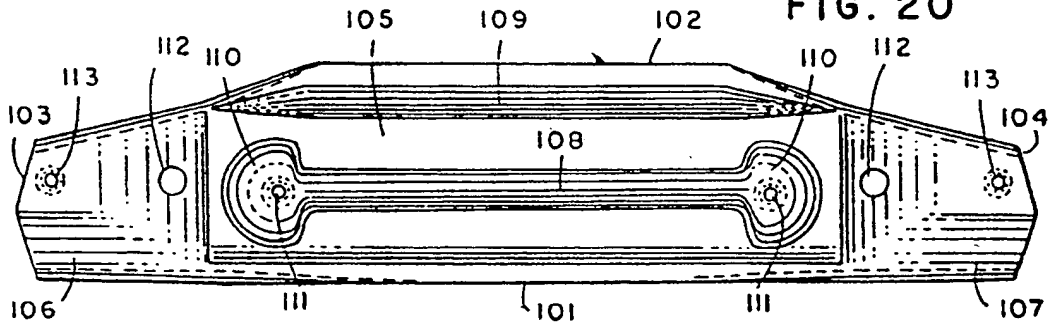



FIG. 20

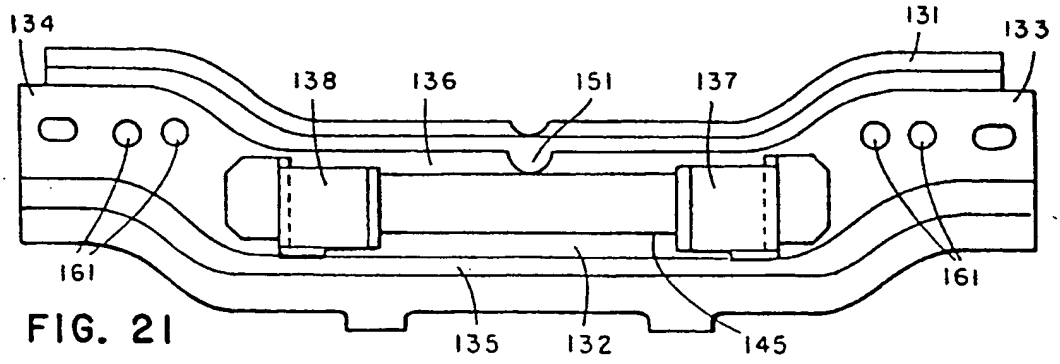
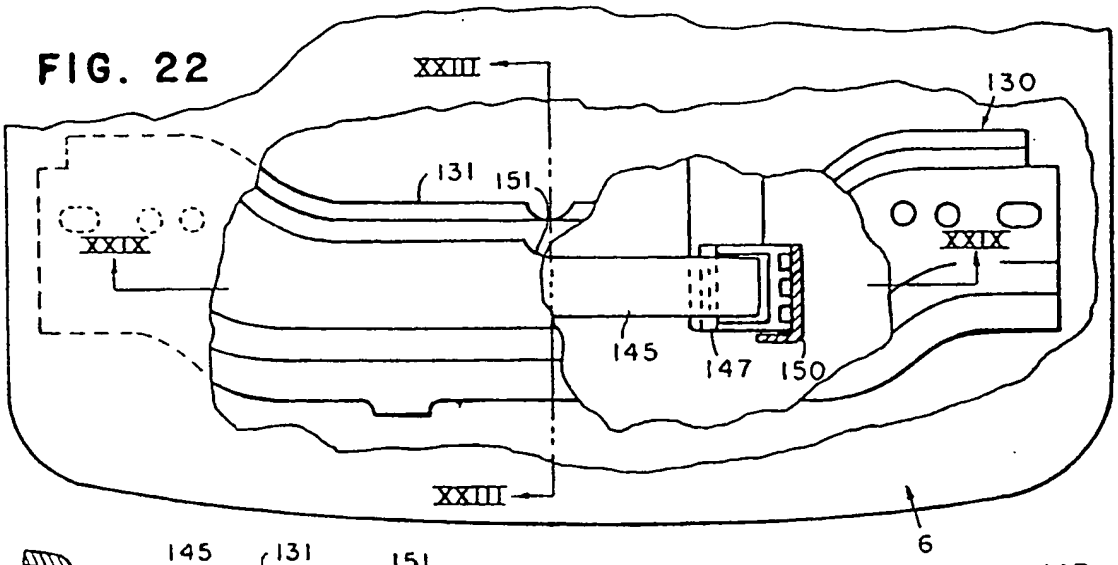



FIG. 21

FIG. 22



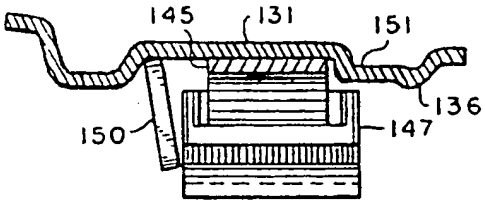




FIG. 23

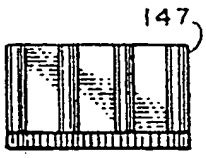



FIG. 24

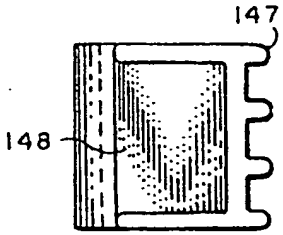



FIG. 25

FIG. 26

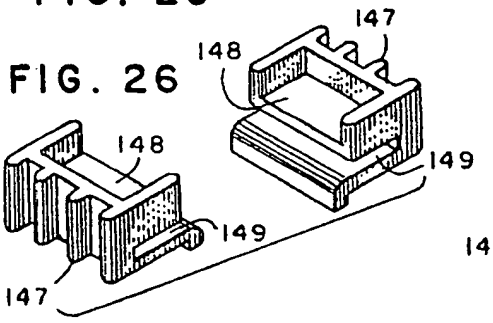



FIG. 27

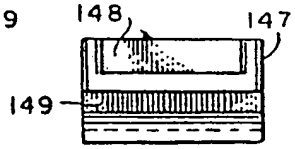
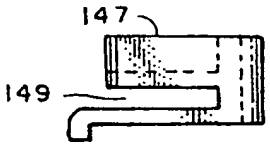



FIG. 28



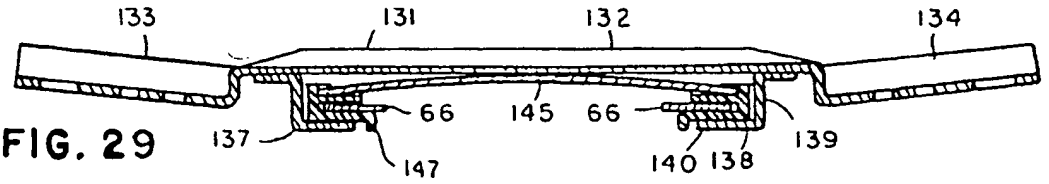




FIG. 29

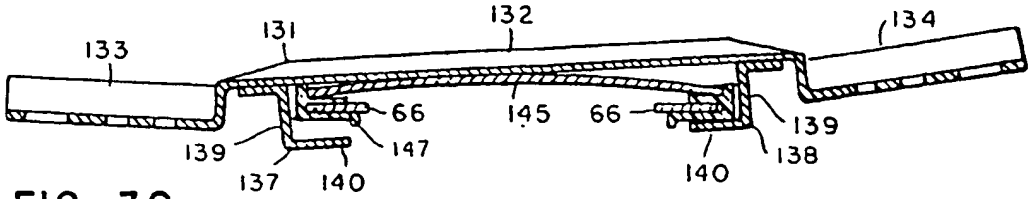



FIG. 30

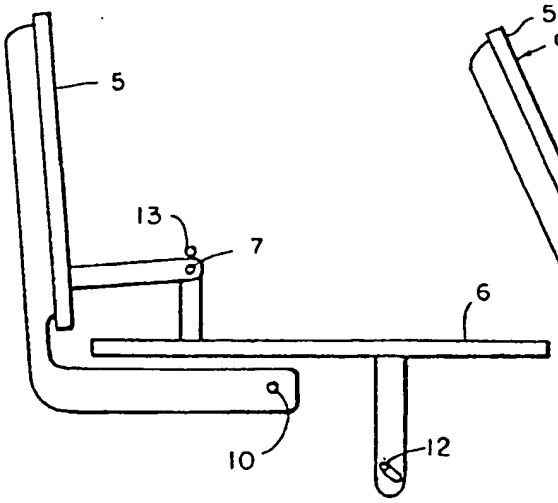



FIG. 31

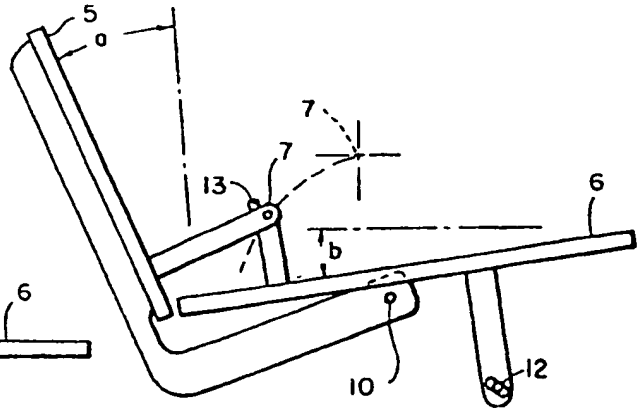



FIG. 32

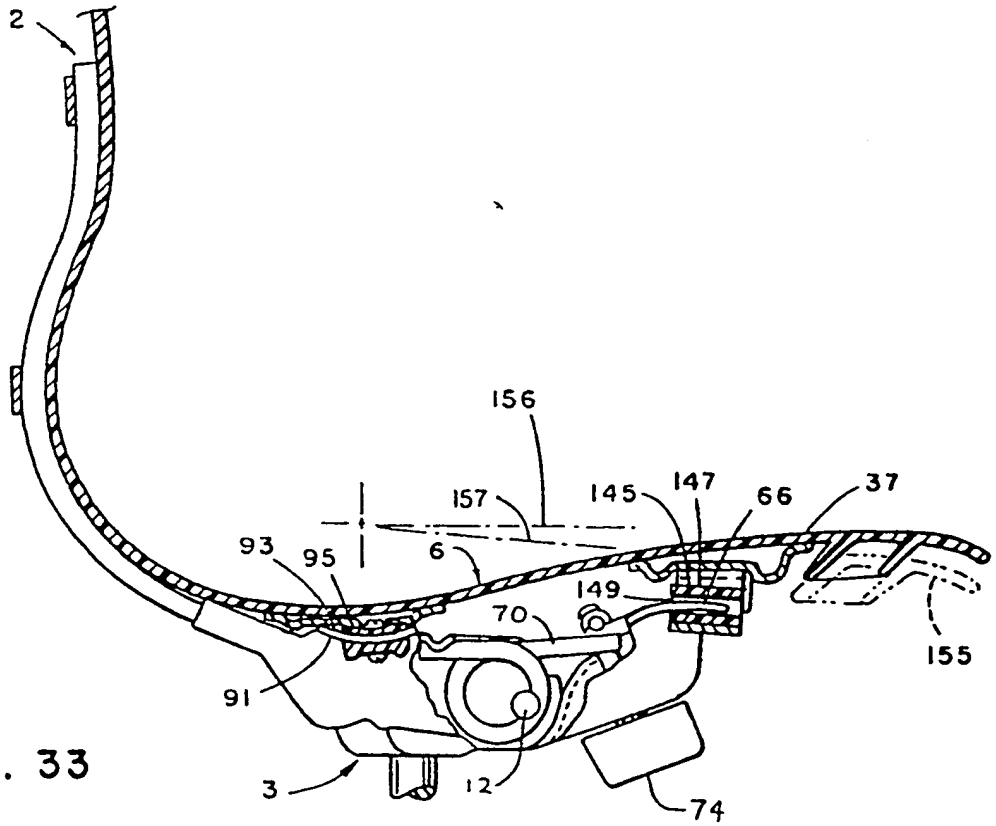



FIG. 33

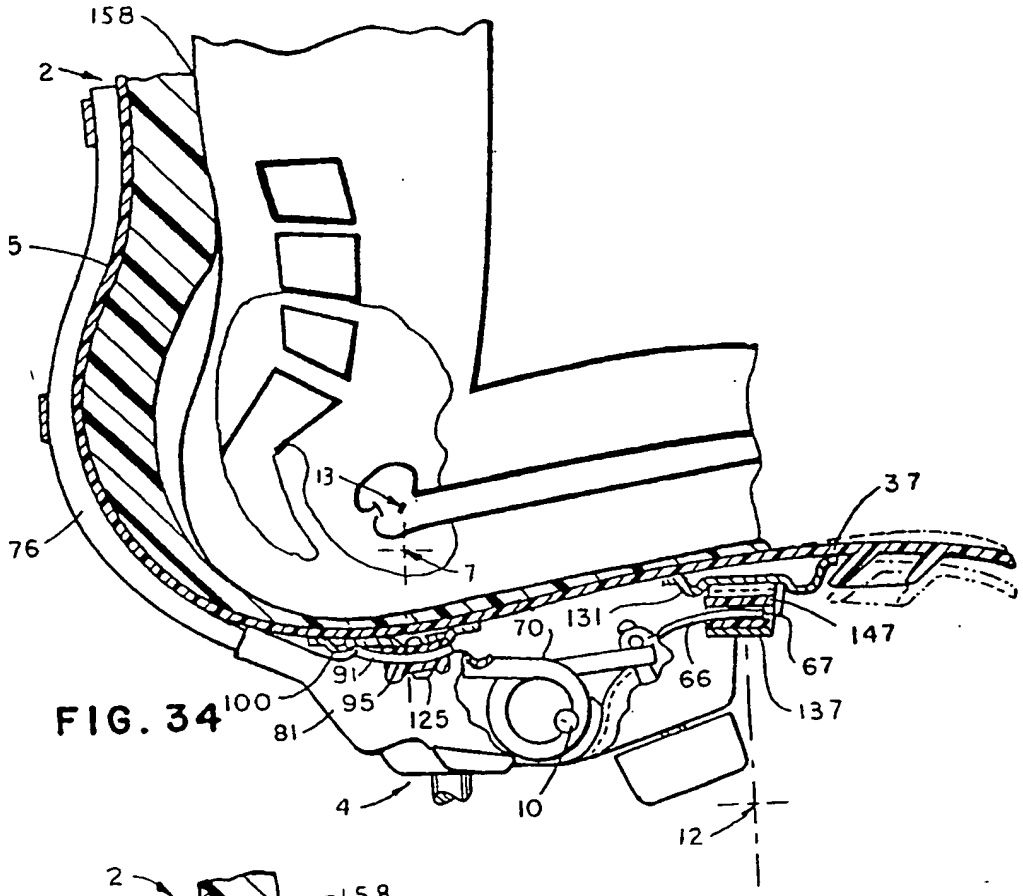

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FIG. 34

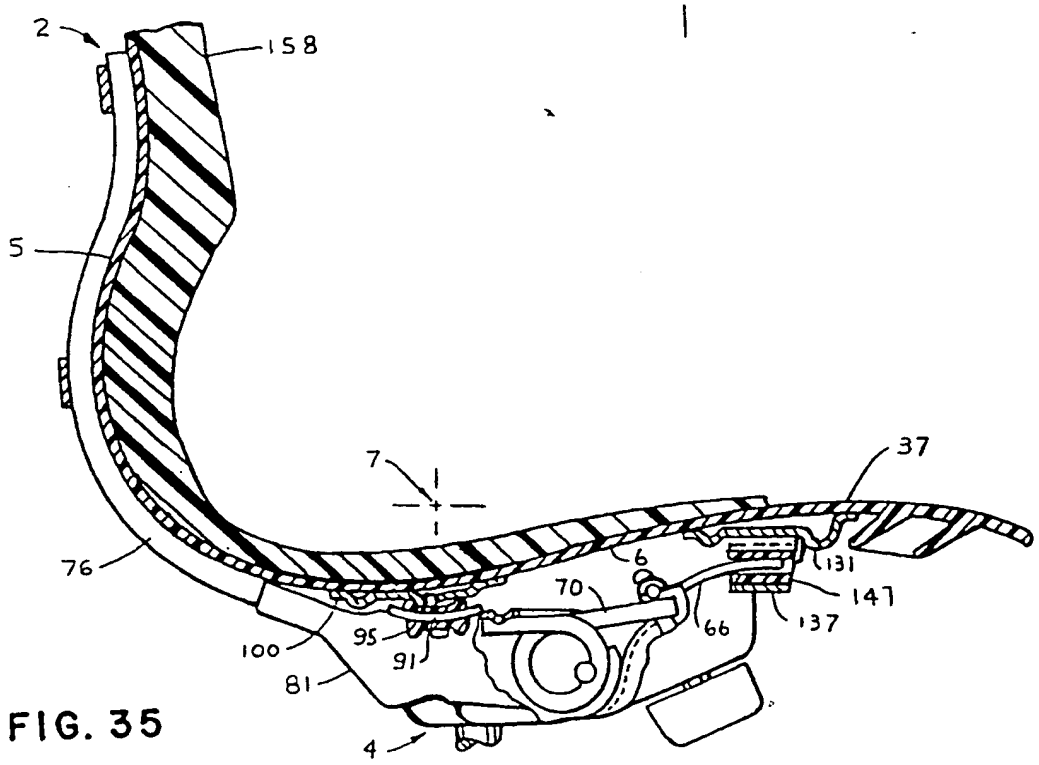
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FIG. 35

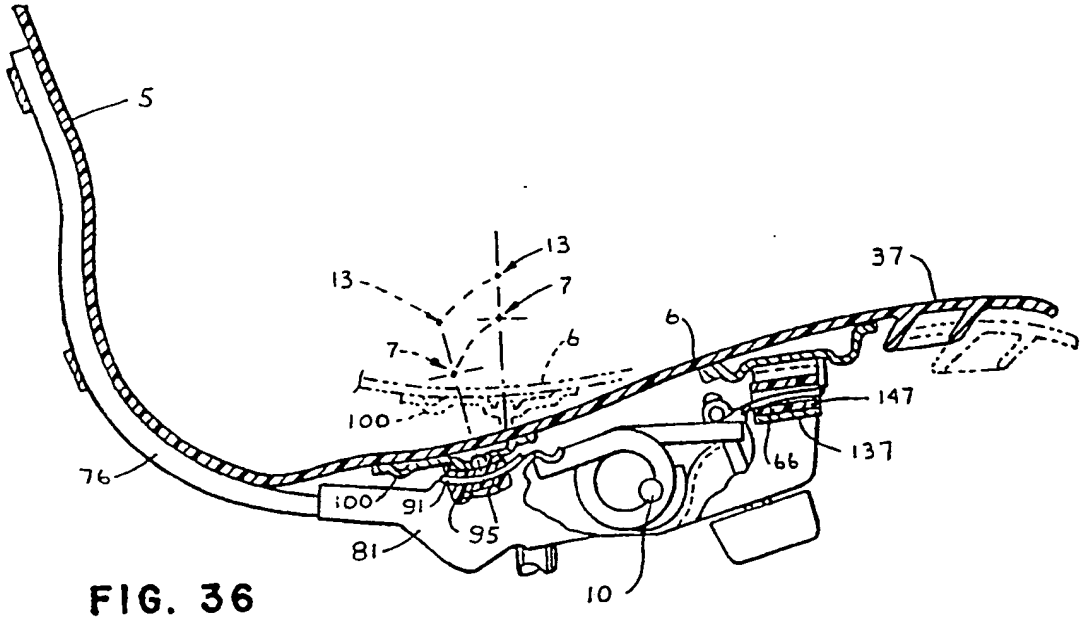
5
13
13
7
7
6
6
37
147
100
137
66
76
100
91
95
81
10

FIG. 36

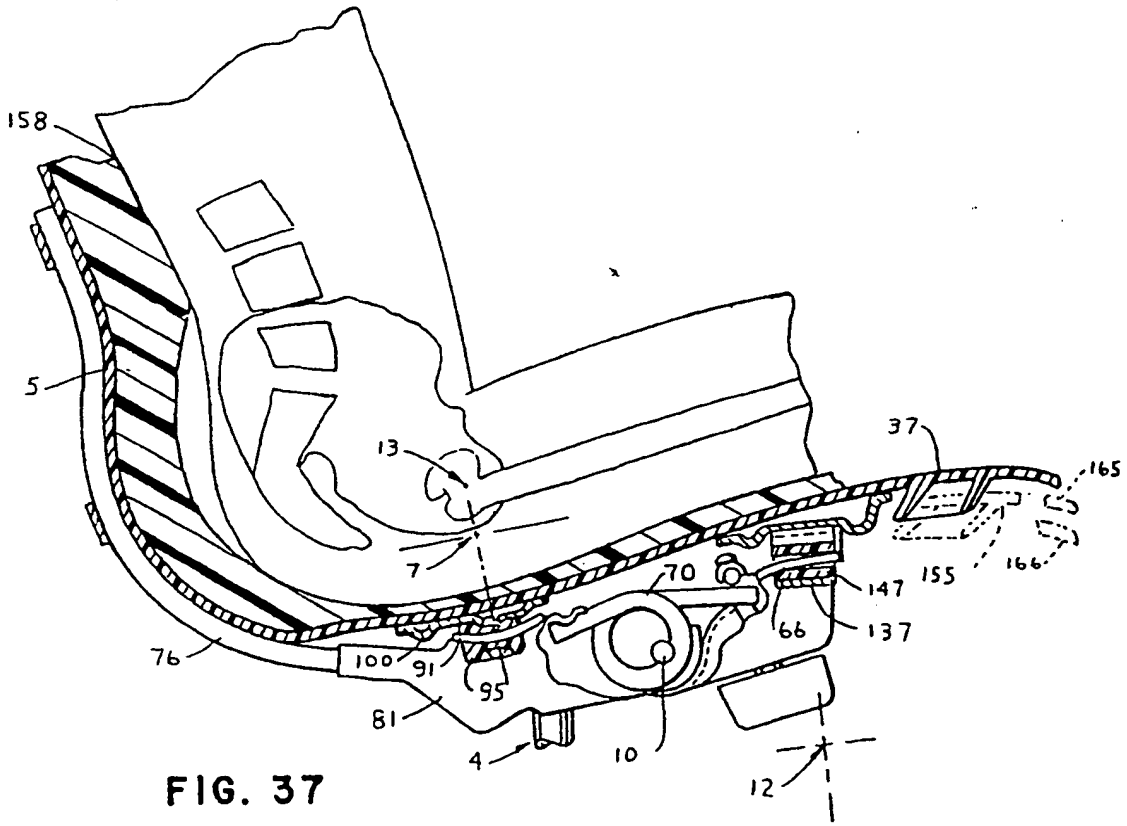
158
5
13
37
165
7
70
147
155
166
66
137
76
100
91
95
81
4
10
12

FIG. 37

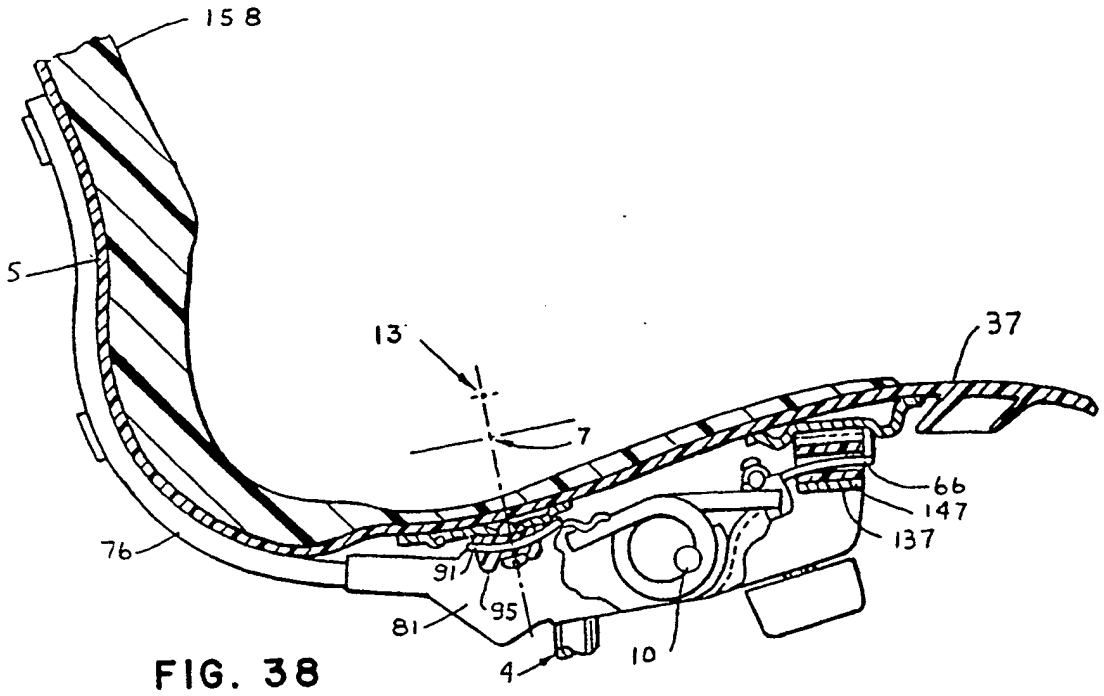


FIG. 38

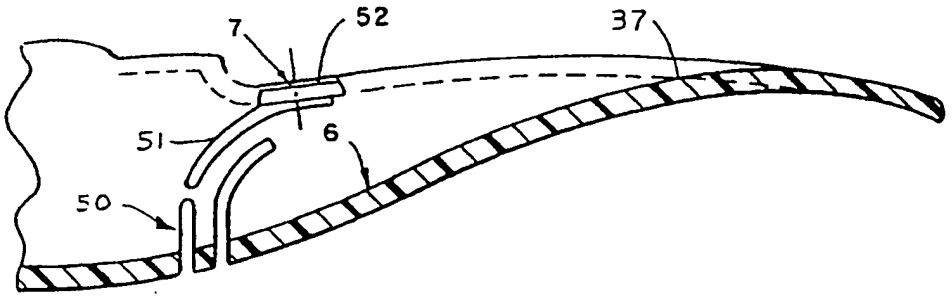


FIG. 39